POPULAR SCIENCE

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MONTHLY

Diving Artillery—

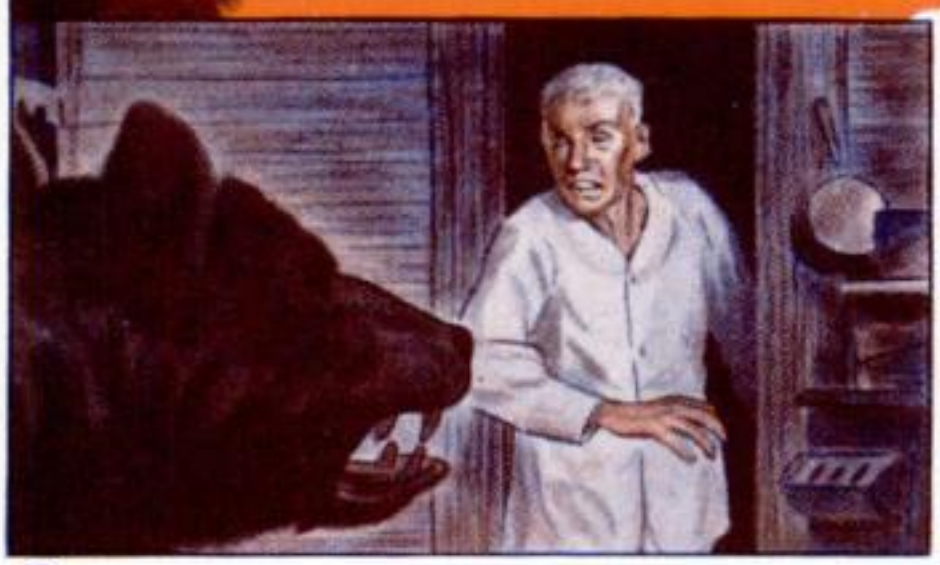
By Hickman Powell—PAGE 90

Save Your Car—

How to Make It Last

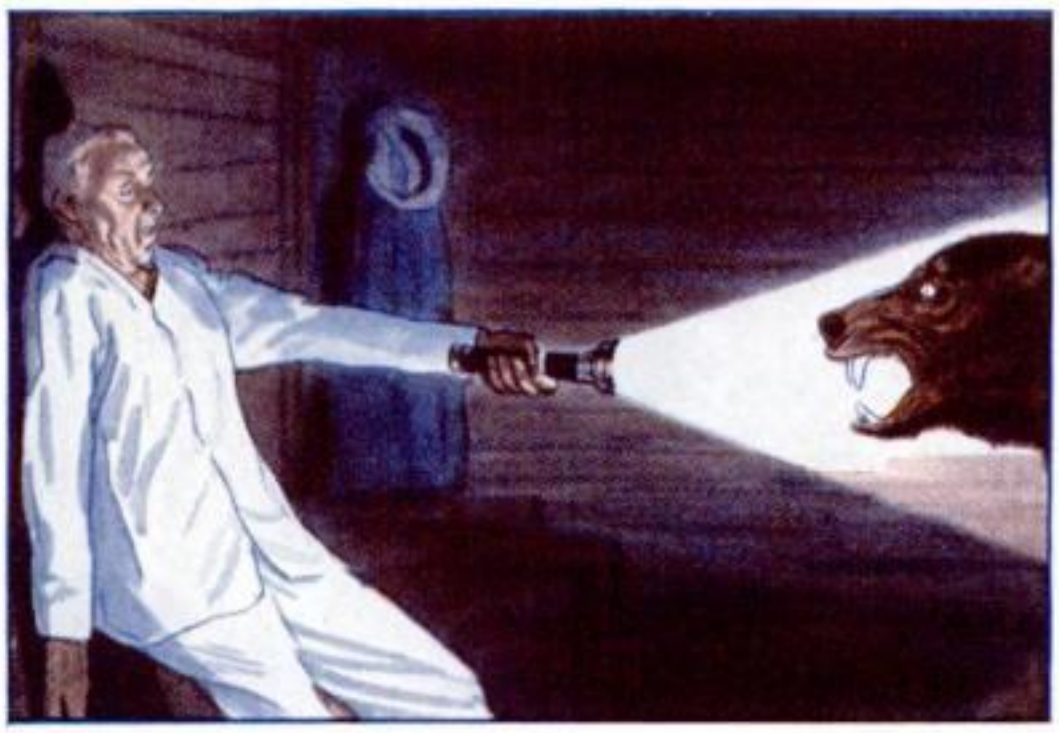
A true experience of
R. S. McILWRAITH,
Libby, Montana

"THE SAVAGE BEAST HAD ME CORNERED!"



1 **"A TERRIFIC CRASH** startled me right out of bed one night as I slept in the cook house of the mining camp where I work," writes Mr. McIlwraith. "Half awake, I rushed into the kitchen to investigate—and found a huge bear had broken in and was tearing into our food supplies.

2 **"MADDENED** by my interruption and savage from hunger, the great creature started for me. My only thought was to get away from him—*and fast*—as these big cinnamons can be bad medicine in close quarters. I darted back into my room. Then to my horror I realized that the bedroom windows were too small for me to get through.



3 **"IN A NIGHTMARE** of panic, I broke out in a cold sweat. Then I remembered my flashlight. Desperately, I grabbed it from a shelf, whirled and flashed it full in the bear's face. He stopped short. Baffled growls came from his dripping jaws . . . and he turned and lumbered out of the shack. It's my hunch that I was one step from being mincemeat when I picked up that 'Eveready' flashlight with its dependable *fresh* DATED batteries.

(Signed) *R. S. McIlwraith*"

The word "Eveready" is a registered trade-mark of National Carbon Company, Inc.

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UCC

but here is one worry you can avoid

MAYBE you can't buy new tires, but you can make your old ones last longer by giving them extra care.

And you can make your *car* last longer, too, if you take *extra* care to avoid *extra* wear on your car's king pins, tie rods, steering crank bearings and other vital friction points that means costly repair bills when neglected! Play safe—with Marfak bumper-to-bumper *chassis lubrication* every 1,000 miles!

Marfak is super-tough. Applied by chart, not by chance—it resists wear-out, wash-out and squeeze-out.

TUNE IN FRED ALLEN every Sunday night. See your local newspaper for time and station.

For your peace of mind, never say "grease job." Insist on reliable Marfak chassis lubrication—your insurance against costly repair bills. At Texaco and other good dealers everywhere.

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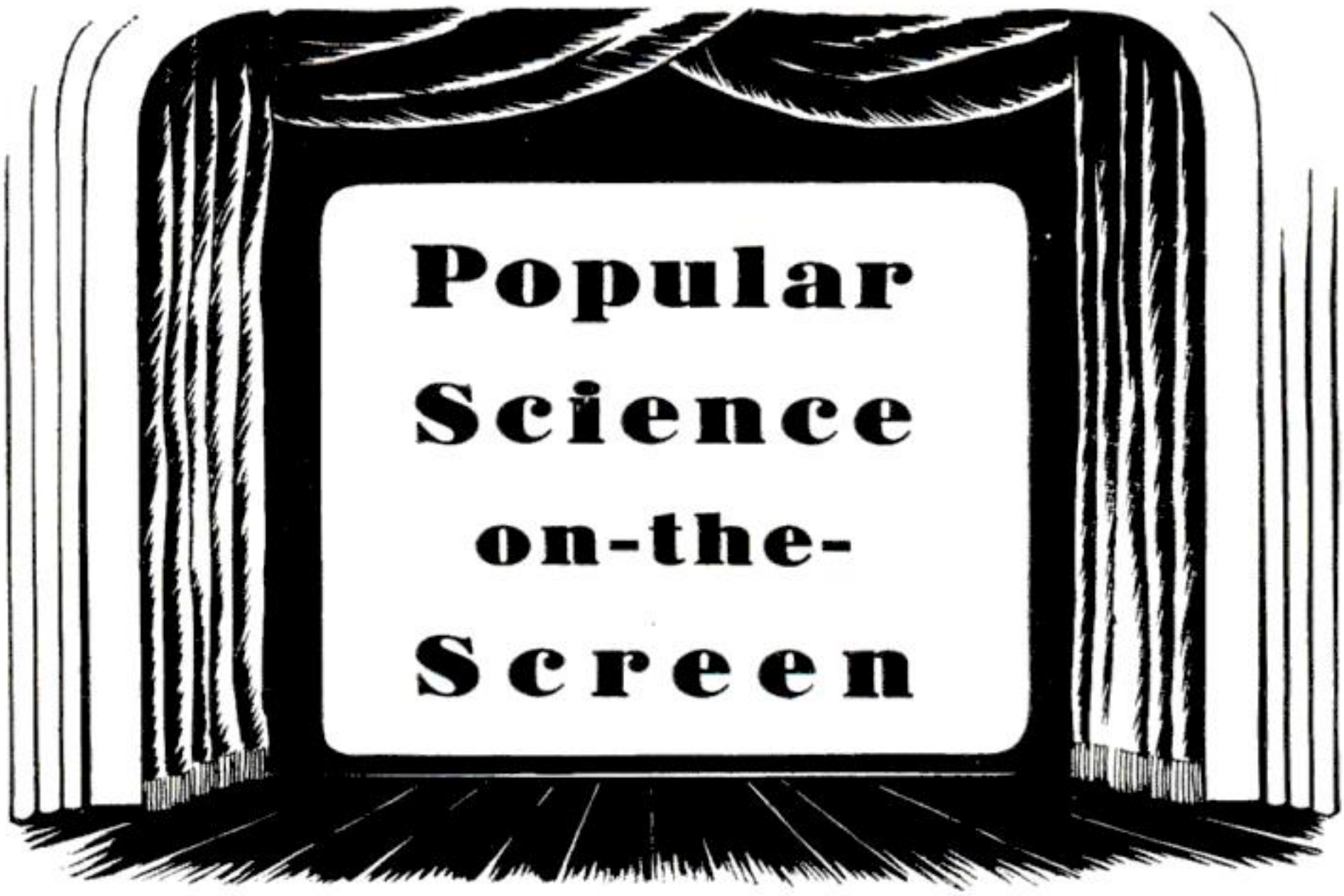

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A great new briar stuffer
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If pleasure's what you covet,
Then, Mate-try FRIENDS!
You'll love it!
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POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 140 NO. 4

Mechanics & Handicraft

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY

CONTENTS *for* APRIL, 1942

News

Automobiles

Home and Workshop

Departments

(Contents continued on page 6)

JO KOTULA, artist of this month's cover, has been drawing airplanes for the last 16 years. While he is not limited to aeronautical subjects, he likes them best. Although now a resident of New Jersey, he has spent most of his 31 years in the Midwest and in Texas. His hobby, as might be expected, is airplanes, and he has been flying his own Taylorcraft for more than five years.

Published monthly at 353 Fourth Avenue, New York, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Vice Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

Single copy, 15 cents; Canada, 20 cents. Yearly subscriptions to United States and its possessions, $1.50; Canada, $2.00; foreign countries, excepting Canada, $2.50. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new address.

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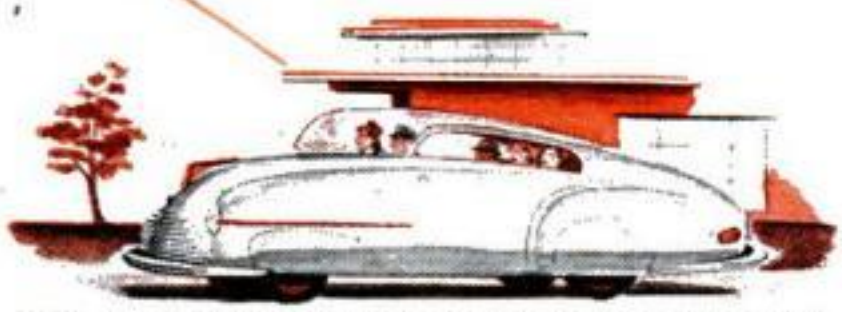
More Vital - More Dependable than ever!

"Keep 'em rolling"—and Champion Spark Plugs do just that. Their many patented features include the Sillment seal which banishes troublesome leakage *common to ordinary spark plugs.* Leaky spark plugs overheat, pre-ignite and cause rough, wasteful engine operation.

It's a sunny "good morning" regardless of weather, when your car starts with the first touch of the starter. Champion Spark Plugs are the key to quick starts in any temperature. It's poor business to handicap your engine with any but the best in these days.



We probably won't have "tomorrow's car" for some time, but that's no reason why your present car can't be kept performing efficiently and economically. Old, worn-out, or dirty spark plugs make a car act old before its time. Have yours checked and cleaned regularly. For greatest gas economy change all spark plugs every 10,000 miles. New ones quickly save their cost.

TO SAVE GASOLINE • KEEP YOUR SPARK PLUGS CLEAN

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Automobiles

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America's TRAINED MEN will win the war !

★

Join up now!

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BEHIND America's trained men in uniform stand the trained men in America's business and industry — helping to produce the weapons that are essential to final victory.

By acquiring sound training, and thus increasing your efficiency on your job, you are helping to smash your country's enemies.

One hundred thousand American men are now studying I. C. S. Courses in 400 business and technical subjects. And after you learn how little it costs to study an I. C. S. Course in your line of work, and how much practical, up-to-date training-for-success you get in return for a few hours of your spare time each week, you'll want to *join their ranks!*

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City.....*State*.....*Present Position*.....

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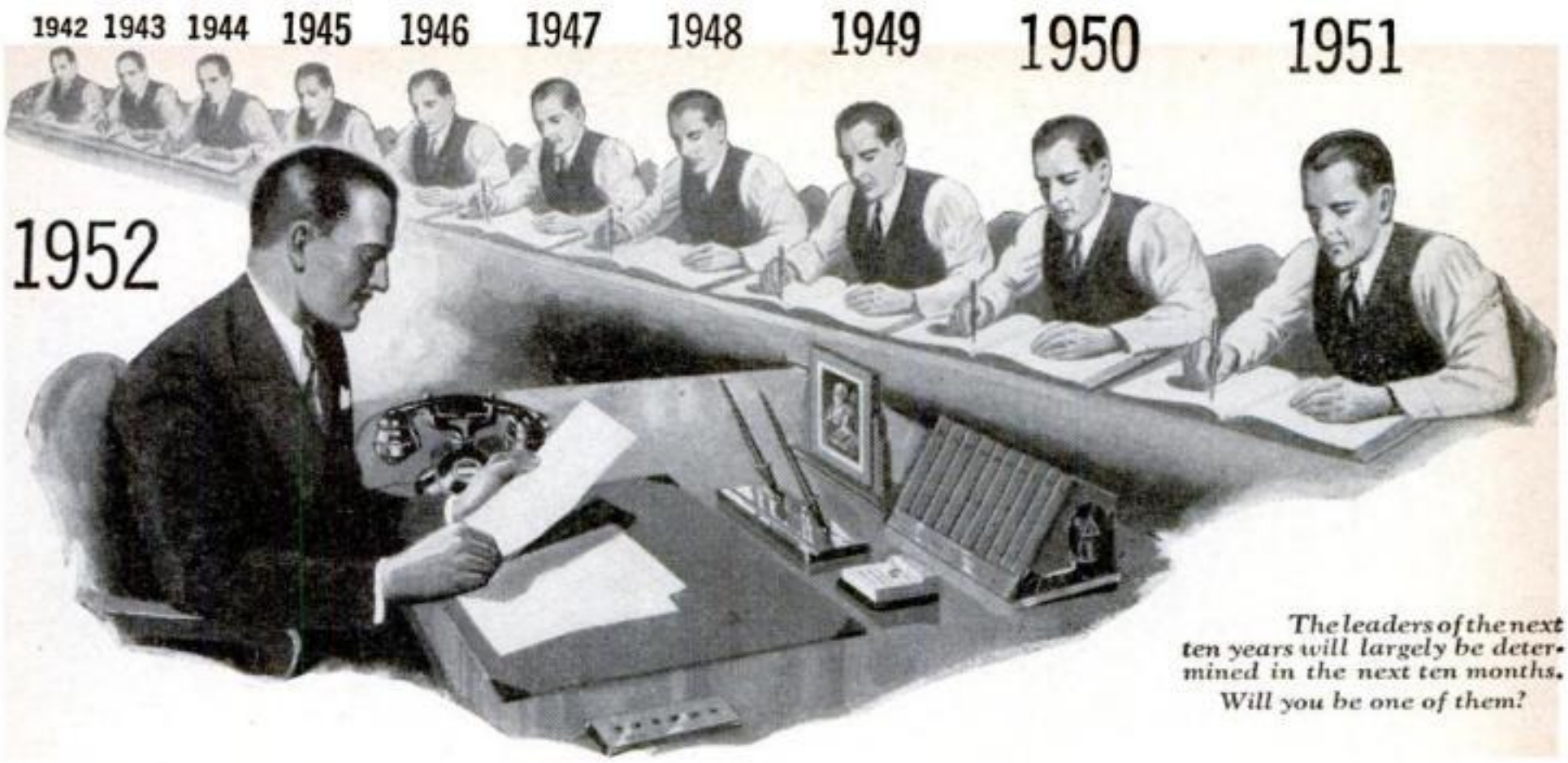

Will You Be Clerk or Manager Ten Years from Now?

"SURELY, this could never happen to *me*," you say—"that I should be sitting at the same desk—be doing the same work—*for ten straight years!*"
But wait a minute—

Exactly that same thing has happened to thousands upon thousands of men. It has probably happened to men right in the company you now are working for. *And—unless you fit yourself for a better job—there is a very good chance that it may happen to you!*

Unthinkable? That's what J. N. Dixon of Columbus, Ohio, said to himself. Yet lack of training kept him slaving away at low wages for a long time.

TRIPLES INCOME

Here is Mr. Dixon's own story—"Just after I returned from the war, one of your representatives found me plugging away at a bookkeeper's job in Marietta, Ohio. He performed a real service and explained to me the need of further training, and induced me to take the LaSalle training in Higher Accountancy. After a few months of study, I secured a position with the Trust Department of a National Bank. This was the stepping stone I needed to various responsible positions including handling of receiverships and other important duties. That quickly boosted my income several hundred percent."

ANOTHER AMAZING SUCCESS STORY

If you think Mr. Dixon's success story too unusual, read what J. H. Krouse of Memphis, Tennessee, says: "When I decided to take your training in Higher Accountancy, I was a clerk. Today I am Chief Consultant Accountant for the U. S. Engineer's Office in Memphis, Tenn. Whatever success or recognition I have had, I owe to your training. I have had no other specialized training along this line. Your method of teaching is not only instructive but highly engaging. I have observed other courses, but firmly believe LaSalle has the best to be had anywhere."

Another bit of evidence is Mr. R. P. Barthalow's experience. Mr. Barthalow is Chief of the Sales Tax Section of the Tax Commission of Ohio, a department which handles over $50,000,000 a year. Mr. Barthalow attributes much of his success to LaSalle training.

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Need you hear more before you investigate the opportunities in Accountancy?

Or will you face the problem of your future NOW—and send to LaSalle and get further facts and particulars?

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☐ C. P. A. Coaching	☐ Industrial Management	☐ Commercial Law
☐ Modern Salesmanship	☐ Modern Business Correspondence	☐ Effective Speaking

Name.....*Age*.....

Present Position.....*Address*.....

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Outdoors

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Be a RADIO Technician

J. E. SMITH, President
National Radio Institute, Established 27 years

Broadcasting Stations employ N. R. I. trained Radio Technicians as operators, installation, maintenance men and in other capacities and pay well.

Set Servicing pays many N. R. I. trained Radio Technicians $30, $40, $50, a week. Others hold their regular jobs and make $5 to $10 extra a week in spare time.

Loudspeaker System building, installing, servicing and operating is another growing field for N. R. I. trained Radio Technicians.

I Trained These Men

$10 a Week in Spare Time

"I repaired some Radio sets when I was on my tenth lesson. I really don't see how you can give so much for such a small amount of money. I made $600 in a year and a half, and I have made an average of $10 a week—just spare time." JOHN JERRY, 1729 Penn St., Denver, Colorado.

Makes $50 a Week

"I am making around $50 a week after all expenses are paid, and I am getting all the Radio Work I can take care of, thanks to N. R. I." H. W. SPANGLER, 126½ S. Gay St., Knoxville, Tenn.

Sergeant in Signal Corps

"I am now a Sergeant in the U. S. Army, Signal Corps. My duties cover Radio operating, maintenance of Army Transmitters and Receivers, operating Teletypes, handling duties of the Chief Operator in his absence." SERGEANT RICHARD W. ANDERSON, U. S. Army (Address omitted for military reasons.)

I Train Beginners at Home for Good Spare Time and Full Time Radio Jobs

More Now Make $30 $40 $50 a Week than Ever Before

Here is a quick way to more pay. Radio offers a way to make $5, $10 a week extra in spare time a few months from now, plus the opportunity for a permanent job in the growing Radio industry. There is an increasing demand for full time Radio Technicians and Radio Operators. Many make $30, $40, $50 a week. On top of increasing civilian interest in Radio, the Radio Industry is rushing to fill millions of dollars worth of Government orders. Clip the Coupon below and mail it. Find out how I train you for these opportunities.

Jobs Like These Go to Men Who Know Radio

The 882 broadcasting stations in the U. S. employ Radio Technicians with average pay among the country's best paid industries. The Radio repair business is booming due to shortage of new sets. Repairing, selling, servicing, installing home and auto Radio receivers (there are 50,197,000 in use) gives good jobs to thousands. Many N. R. I. trained Radio Technicians take advantage of the opportunities to have their own full time or spare time Radio service businesses. The Government needs many Civilian Radio Operators, Technicians. Think of the many good jobs in connection with Aviation, Commercial, Police Radio and Public Address Systems. N. R. I. gives you the required knowledge of Radio for these jobs. N. R. I. trains you to be ready when Television opens jobs in the future. Yes, N. R. I. trained Radio Technicians make good money because they use their heads as well as their hands. They are THOROUGHLY TRAINED. Many N. R. I. trained men hold their regular jobs, and make extra money fixing Radio sets in spare time.

Beginners Soon Learn to Make $5, $10 a Week Extra in Spare Time

Nearly every neighborhood offers opportunities for a good part time Radio Technician to make extra money fixing Radio sets. I give you special training to show you how to start cashing in on these opportunities early. You get Radio parts and instructions for building test equipment, for conducting experiments which give you valuable practical experience. My 50-50 method—half working with Radio parts, half studying my lesson texts—makes learning Radio at home interesting, fascinating, practical.

Extra Pay in Army, Navy, Too

Men likely to go into military service, soldiers, sailors, marines, should mail the Coupon Now! Learning Radio helps men get extra rank, extra prestige, more interesting duty at pay up to 6 times a private's base pay. Also prepares for good Radio jobs after service ends. IT'S SMART TO TRAIN FOR RADIO NOW!

Find Out How N. R. I. Teaches Radio and Television

Act today. Mail coupon now for 64-page Book. It's FREE. It points out Radio's spare time and full time opportunities and those coming in Television; tells about my Course in Radio and Television; shows more than 100 letters from men I trained, telling what they are doing and earning. Find out what Radio offers you. Mail coupon in envelope or paste on penny postcard—NOW.

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NAME.....AGE.....

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CITY.....STATE.....

Coming Next Month—

WHAT LIES AHEAD for American science and industry after the war? That is the question *Popular Science* asked "Boss" Kettering, one of the leaders in industrial research. In an exclusive article, Mr. Kettering examines the problems and opportunities of the coming years.

CIVILIAN DEFENSE VOLUNTEERS will be interested in a description of a homemade airplane detector that can be constructed from radio parts and other easily obtainable materials. Operating on the principle of the big "ears" used by the Army, it will spot an approaching German bomber (or the noon airliner to Chicago) at a distance of five or ten miles.

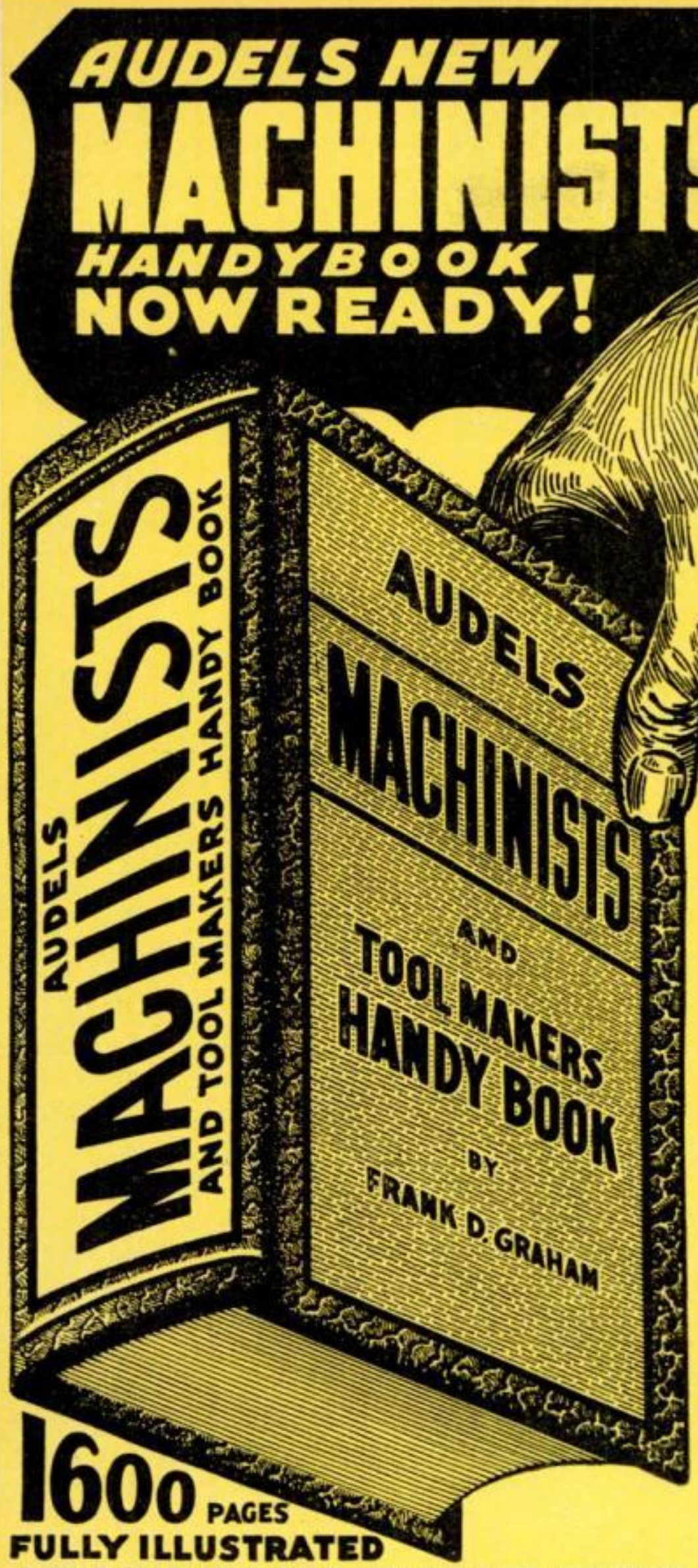
IN ALL-OUT WAR, health is an important weapon. To help offset the strain of the emergency and keep war-industries workers at their benches and machines, vitamins are being drafted for the duration. How these nerve-bracing, energy-building substances are contributing to ultimate victory is told in an informative article.

HOME WORKSHOPS are on the war front, with hobbyists registering by thousands for possible service in defense production. Two practical questions suggest themselves to the amateur craftsman: how to obtain war work, and how to tool up his shop for maximum production. These are answered in brass-tacks style by C. W. Woodson in a new article in the popular series, "Machinists for Defense."

"THE PORCUPINE SQUADRON" is what they call it, and you'll understand why when you read about the tactics used by this 100-percent-American development in military aviation. Hugging the ground, their backs bristling with weapons against enemy fighters, the U. S. Army's attack bombers can make plenty of trouble for Axis supply columns and troop concentrations.

EFFICIENT CLOSETS, planned to suit the actual needs of the persons using them, can add greatly to the comfort of the home. And any moderately competent home craftsman can do the planning, with the aid of sketches and suggestions offered by Joseph Aronson, well-known designer. Another practical project for improving your home—now!

AUDELS NEW MACHINISTS HANDYBOOK NOW READY!



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Mail AUDELS MACHINISTS & TOOLMAKERS HANDY BOOK, Price $4 on 7 Days Free Trial. If O. K. I will remit $1 in 7 days and $1 Monthly until $4 is Paid. Otherwise I will return it.

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Address_____

Occupation_____

Reference_____ PSM

From the News Editor's Desk

SOYBEAN MEAL is transformed into a substitute for rubber by a confidential process recently developed by the U. S. Department of Agriculture. A series of chemical changes transforms the protein molecules of the soybean meal into molecules similar in structure to those of rubber. Since 1936 industrial chemists have utilized soybean products in the manufacture of adhesives, plastics, paper finishes, synthetic fiber for automobile upholstery, and a substitute for tung oil.

WORN MACHINE PARTS such as shafts, bearings, pistons, etc., can be built up to their original dimensions at one third to one half the cost of new parts, according to W. J. Cumming, automotive engineer. The building up is accomplished by spraying the worn part with a fine mist of molten metal after the old surface has been roughened to make the two metals interlock. The built-up piece is then machined to the proper size and quality of surface.

BREAD IS PROTECTED from mold by the addition of a small quantity of "mold inhibitor," a substance that is naturally present in many other foodstuffs. This agent, when added to the bread dough before baking, checks the development of mold particles for a period of several days after the bread has been unwrapped. Approximately two ounces of the agent will protect 100 loaves. It does not affect the taste or appearance and is expected to cut down substantially the enormous loss of bread due to mold.

SHORT TEMPERS, tearfulness, poor memory, or a constant scared feeling can often be cured in from 30 minutes to 20 hours by an injection of vitamin B-1 (thiamin). According to Dr. Tom D. Spies of the University of Cincinnati, patients lacking this important vitamin in their everyday diet are liable to show these emotional symptoms. In some cases, where the lack of B-1 has caused serious damage to the brain cells, the injection treatment takes a longer period of time.

AN ALLY OF THE SULFA DRUGS is now being used to reduce the long, dull pain experienced after a simple dental extraction. Para-nitrobenzoic acid, the technical name for the drug, was found to deaden the post-extraction pain in all but three out of 528 cases recently tested. The drug is also said to be the most deadly agent of the sulfa compounds against the streptococcus viridans germ which is most frequently found in an infected tooth socket.

15 Minutes a Day!

Give me just this and I'll prove I can make you

A NEW MAN!

I'M "trading-in" old bodies for new! I'm taking men who know that the condition of their arms, shoulders, chests and legs—their strength, "wind," and endurance—is not 100%. And I'm making NEW MEN of them. *Right now* I'm even training hundreds of soldiers and sailors who KNOW they've got to get into shape FAST!

Only 15 Minutes a Day!

Are you ALL MAN—tough-muscled, on your toes every minute, with all the up-and-at-'em that can lick your weight in wildcats? *Or do you need the help I can give you*—the help that has already worked such wonders for other fellows, everywhere?

All the world knows I was ONCE a skinny, scrawny 97-lb weakling. And NOW it knows that I am the holder of the title, "The World's Most Perfectly Developed Man." How did I do it? How do I work miracles with the bodies of other men in only 15 minutes a day? The answer is *Dynamic Tension*, the amazing method I discovered and which changed me from a 97-pound weakling into the champion you see here!

In just 15 minutes a day, right in the privacy of your own home, I'm ready to prove that *Dynamic Tension* can lay a new outfit of solid muscle over every inch of your body. Let me put new, smashing power into your arms and shoulders—give you an armor-shield of stomach muscle—strengthen your legs into real columns of surging stamina. If lack of exercise or wrong living has weakened you *inside*, I'll get after that condition, too, and show you how it feels to LIVE!

Charles Atlas
—actual photo of the man who holds the title, "The World's Most Perfectly Developed Man."

Charles Atlas—America's Greatest "Builder of Men"

Among all the physical instructors and "conditioners of men" ONLY ONE NAME STANDS OUT. That name is Charles Atlas!

In every part of the country Charles Atlas is recognized as "America's Greatest Builder of Men." Almost two million men have written to him. Thousands upon thousands have put their physical development into his capable hands!

And now that the call is for men capable of helping America meet and conquer any national emergency, many thousands of others (even those already in their country's Army and Navy) are calling upon Charles Atlas to build the kind of men America vitally needs!

MAIL THIS COUPON NOW!

FREE ***This Famous Book that Tells You How to Get a Body that Men Respect and Women Admire***

Over two million men have sent for and read my book, *"Everlasting Health and Strength."* It tells you exactly what *Dynamic Tension* can do. And it's packed with pictures that SHOW you what it does. RESULTS it has produced for other men. RESULTS I want to prove it can get for YOU! If you want to learn how you can actually become a NEW MAN, right in the privacy of your own home and in only 15 minutes a day, then man!—get this coupon into the mail to me as fast as your legs can get to the letterbox! CHARLES ATLAS, Dept. 1-S, 115 East 23rd St., New York City.

CHARLES ATLAS, Dept. 1-S
115 East 23rd St., New York City

I want the proof that your system of **"Dynamic Tension"** will help make a New Man of me—give me a healthy, husky body and big muscular development. Send me your free book, **"Everlasting Health and Strength."**

Name.....
(Please print or write plainly)

Address.....

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Readers Say:

Don't Let This Worry You—It's Not as Hard as It Sounds

LET your readers have a try at this problem: Two battleships are traveling toward each other, each at a speed of ten knots. When they are one nautical mile apart, a speedboat starts from one vessel to the other at a speed of 30 knots. As soon as it reaches the second ship, it turns around and heads back for the first, and continues to do this until the bows of the two ships are directly opposite each other. Assuming that no time is lost in turning around, how far will the speedboat have traveled altogether?—J. E., Whitestone, N. Y.

Technical Sergeant's Son Catches Us on Chevrons

ON PAGE 89 of your March issue you have a picture of a sergeant looking at photographs through a stereoscopic viewer. He is described as a technical sergeant. If you will notice, he has three stripes below the upper three, which places him in the grade of a master sergeant. I may as well take this opportunity to tell you I think your magazine is swell. I have been reading it for quite some time and have never written to you, but since my father is a technical sergeant I couldn't let that one go.—V. M., New York City.

Another Mysterious Color Change Caused by Ink and Camphor

I'M NOT a know-all, so I won't try to answer the question of D. P., Sheboygan, Wis., about the discoloration of the labels he stuck on his linotype machine, but here's a problem almost the same as his: While working with camphor, I accidentally spilled some on a sheet of paper with some printing on it. I didn't think much of it until a short time later when I discovered that the area which the camphor had hit had taken on a bluish tinge. Apparently the ink had reacted with the camphor. What caused this reaction, and was it similar to that on D. P.'s linotype machine? Does rubber cement have camphor in it? If so, what made his paper turn green and mine blue?—J. K., Charles City, Iowa.

Wonder If He Could Mean Ex-Corporal Hitler?

WHEN I wrote you that letter from Holdingford, Minn., telling how a movie operator (excuse me—*projectionist*) passes his time, I seem to have started quite an argument. After writing it, I joined the Army and was on my way to camp when I bought a copy of P.S.M. in Cincinnati, Ohio. I opened it to your Readers Say column and there was my letter. When I got to my camp in Virginia I got another issue, and there was the retort of G. B., Riffle, W. Va. Now that I've been moved up to Missouri I again opened a POPULAR SCIENCE, and up popped the letter of P. R. B., Madelia, Minn. I wish to thank him for finding an answer for me, and am glad that it was a Minnesota projectionist who came to my rescue. If I can gain the amount of experience necessary to make a projectionist out of an operator, but in a different line—making a soldier out of a rookie—I know some certain people who will have some trouble. —Pvt. J. J. W., Fort Leonard Wood, Mo.

Wrench for Gas-Meter Valve Might Come In Handy

HAVING read recently that it will be necessary to close gas meters if an air raid occurs, I decided to equip all the meters in the building in which I live with permanent wrenches. I did so by inserting a six-inch spike (or larger) in the hole of the valve spindle. If it becomes necessary to close the valve, you simply pull on the spike as you would on a wrench. This will eliminate the loss of valuable time spent in looking for a wrench and inserting it properly—particularly during a blackout. This may be of value to your readers.—M. S., New York, N. Y.

During the present emergency very few new Sea-Horse outboard motors will be available. Johnson facilities today are largely given over to defense production. But call upon your Johnson Dealer nevertheless. He is in touch with the situation. If anyone can help you get a motor, new or used—or assist you with service—he can. Look for his name under "Outboard Motors" in your classified telephone book.

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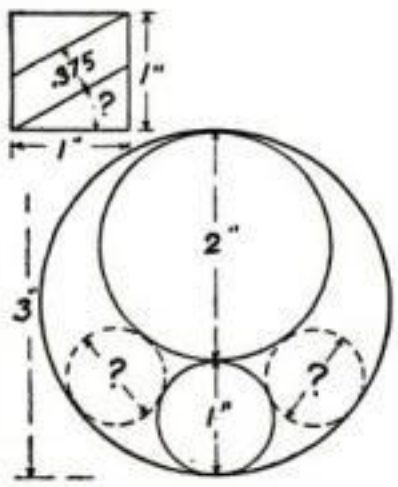
Readers Say:

These Ought To Hold F. P. for a While, at Least



F. P., of Bradford, Pa., asked for problems. He might try these in his spare time. I suggest that he tackle the square first before straining a cell or two on the circle. Note to F. P.: If you solve the circle, slip me the formula, will you, Pal?—D. K. G., Seattle, Wash.

There Wasn't So Much Wrong with That Picture, After All

SEVERAL years ago you ran a contest "What's Wrong with This Picture," and in one of the pictures you showed a man using a sweep brace and a steel drill for drilling a concrete wall to set a bolt or an anchor. Two years ago I had occasion to sheet the walls above my bench for tool supports. It meant drilling into the concrete and setting screw anchors. Just for curiosity's sake I imitated the man in the picture and found that I *could* drill four holes out of five just that way—with an ordinary ten-cent iron drill in a sweep brace. Where there was flint rock in the concrete mixture, the drill would not cut and it took time even with a star drill and hammer to finish it.—C. R. M., Minneapolis, Minn.

Fingernail Polish Will Hold Radio Dial Lights in Place

HERE'S a "Radio Idea" I'm sure would be helpful to others of your readers: The small dial lights usually loosen as a result of expansion and contraction, and it is a bother to fish in a set and screw the light back so it will work. I find that putting fingernail polish or lacquer on the side of the socket and having it overlap onto the light makes a permanent lock.—C. B., Chicago, Ill.

Readers Say:

A Second for the Motion on Tool-Making Articles

LET me second the request of E. C. W., Sydney, Australia, for more articles on the making of tools. I think the ideal author of such articles would be Chester W. Woodson. I have followed Mr. Woodson's articles through a number of publications and have seen nothing that could come even a close second to them.—E. M. S., Long Island City, N. Y.

He's Still Waiting for Plans for a Radio-Controlled Boat

RECENTLY I renewed my subscription to P. S.M. for fear I might possibly miss the article I have been waiting for—a radio-controlled miniature boat. Everything on model airplanes, but never anything on miniature boats. I think that radio-controlled boats could be quite as interesting as model airplanes. I have written a dozen or more letters here and there, trying to find plans to build a model boat suitable for radio control. If it were to be powered with an automobile battery and an electric motor, the boat would have to be designed to provide space for all this equipment and also not sink. If any of you fellows have had any experience with radio-controlled miniature boats, pass the information along to the magazine.—R. S.H., Barnesville, Ohio.

Unbreakable Test Tubes of Plastic Would Cut Laboratory Costs

MUCH has been written about nonbreakable transparent plastics. Why don't they make laboratory glassware for the amateur out of some inexpensive material of this kind, to reduce the danger and expense of breakage?—V. H. Y., Geneva, Ill.

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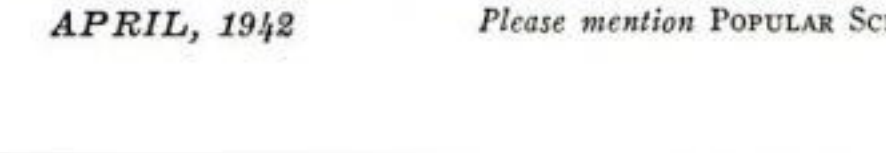

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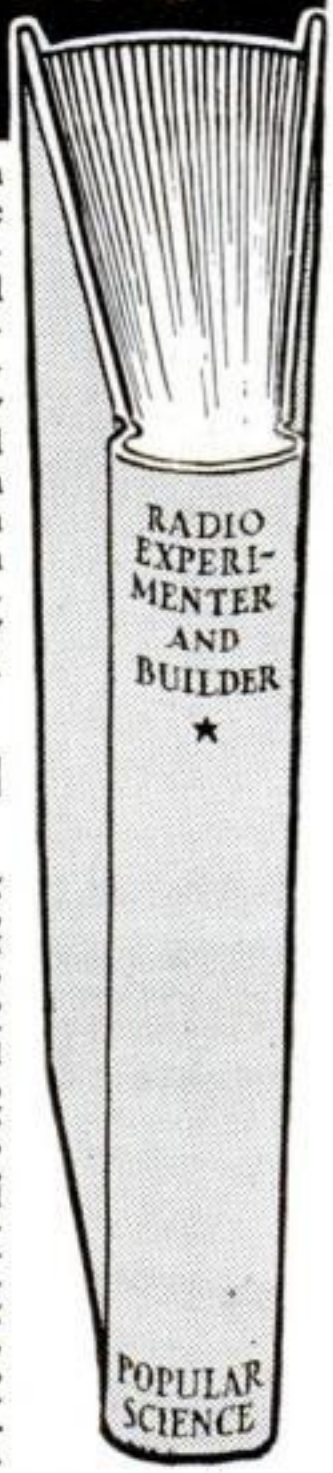

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(Continued on page 24)

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(Continued from page 22)

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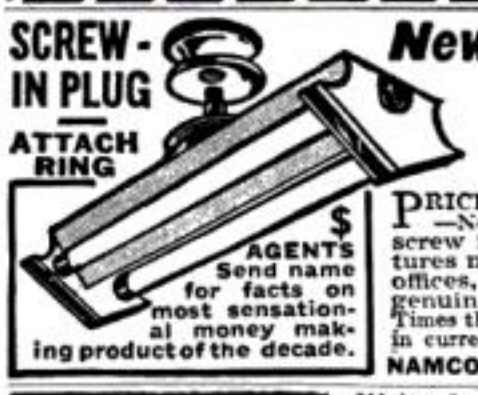

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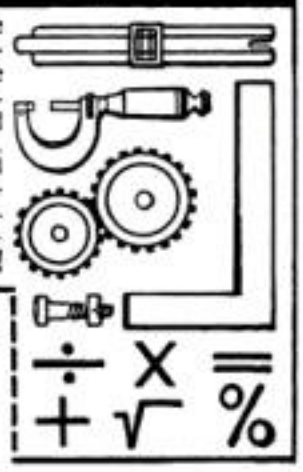

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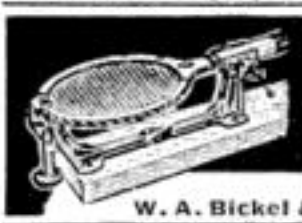

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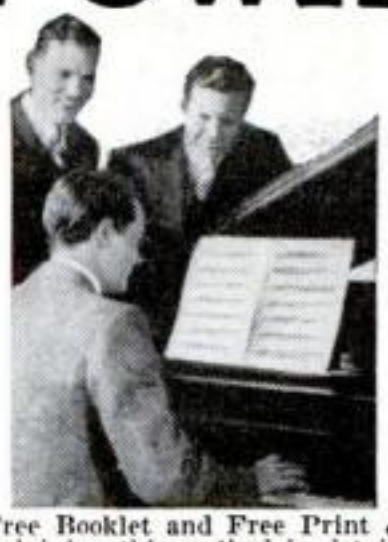

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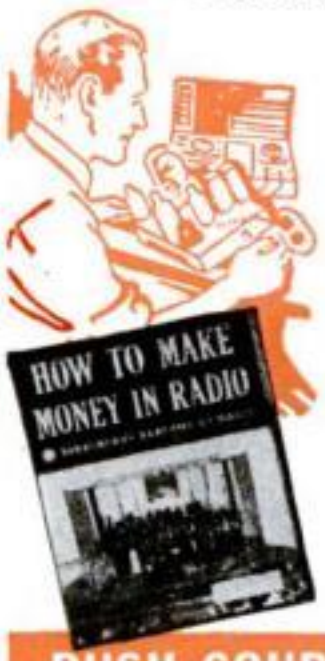

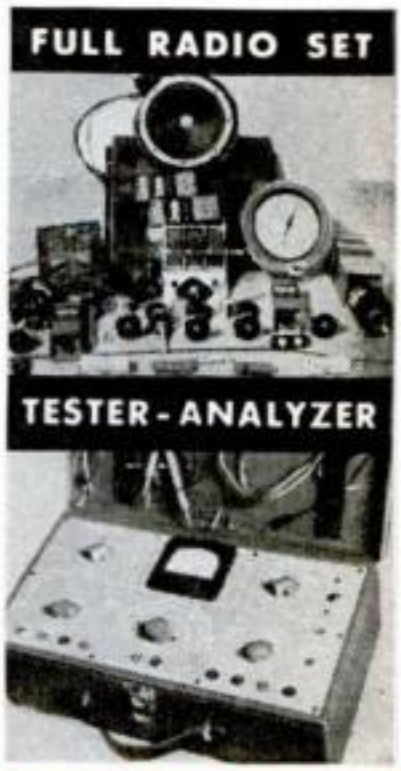

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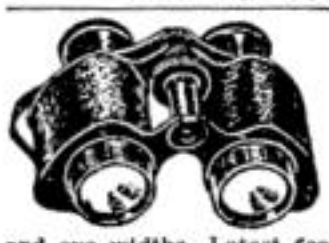

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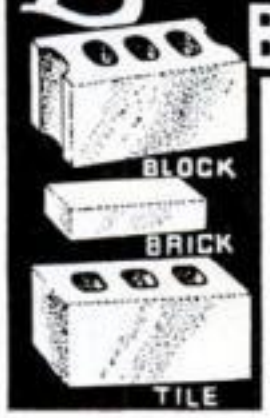

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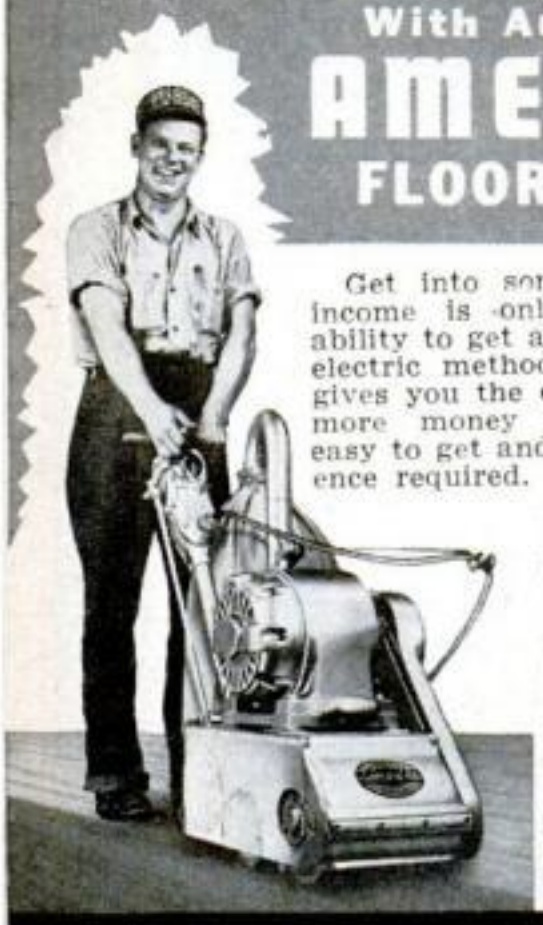

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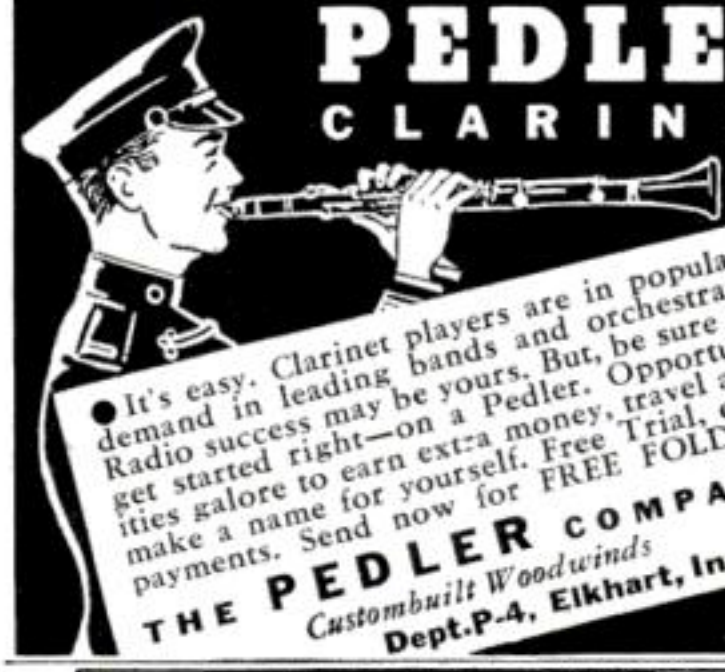

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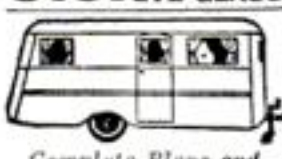

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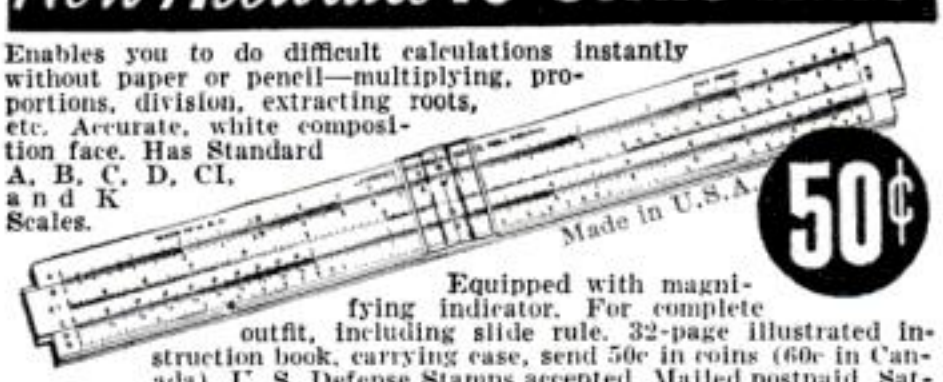

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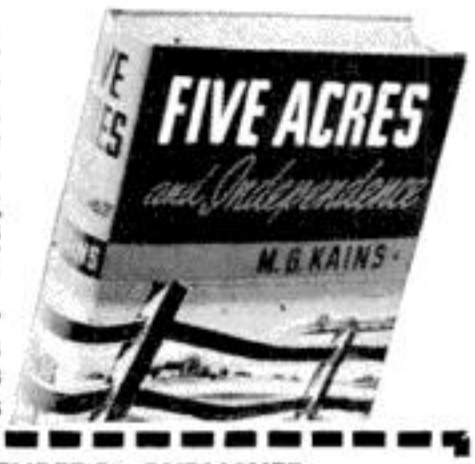

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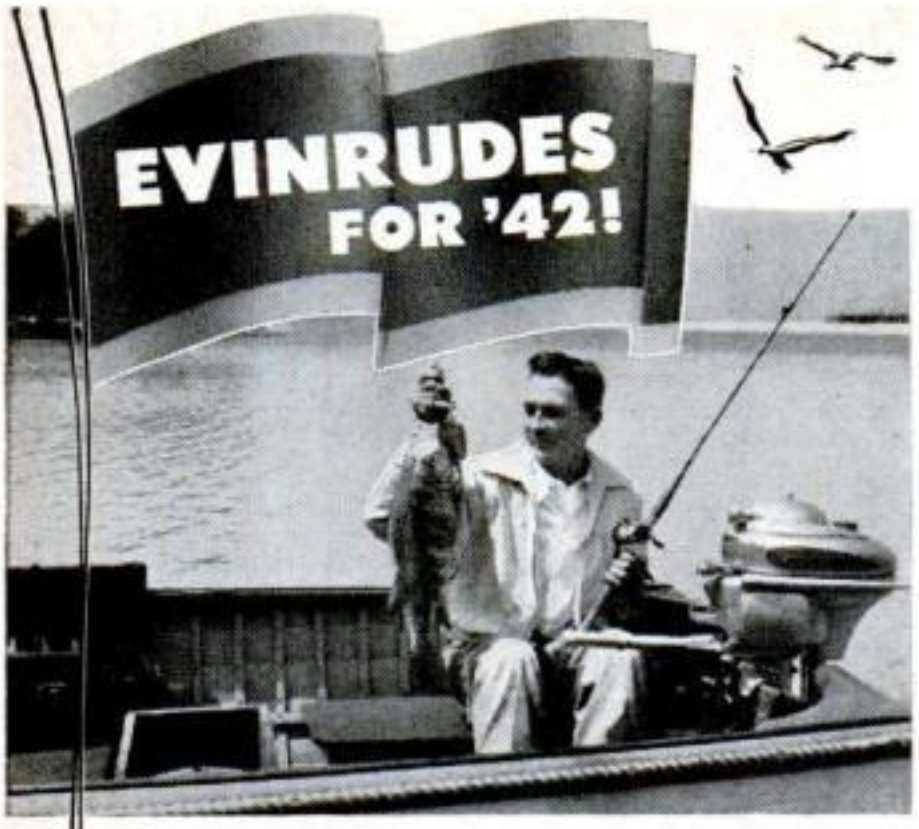

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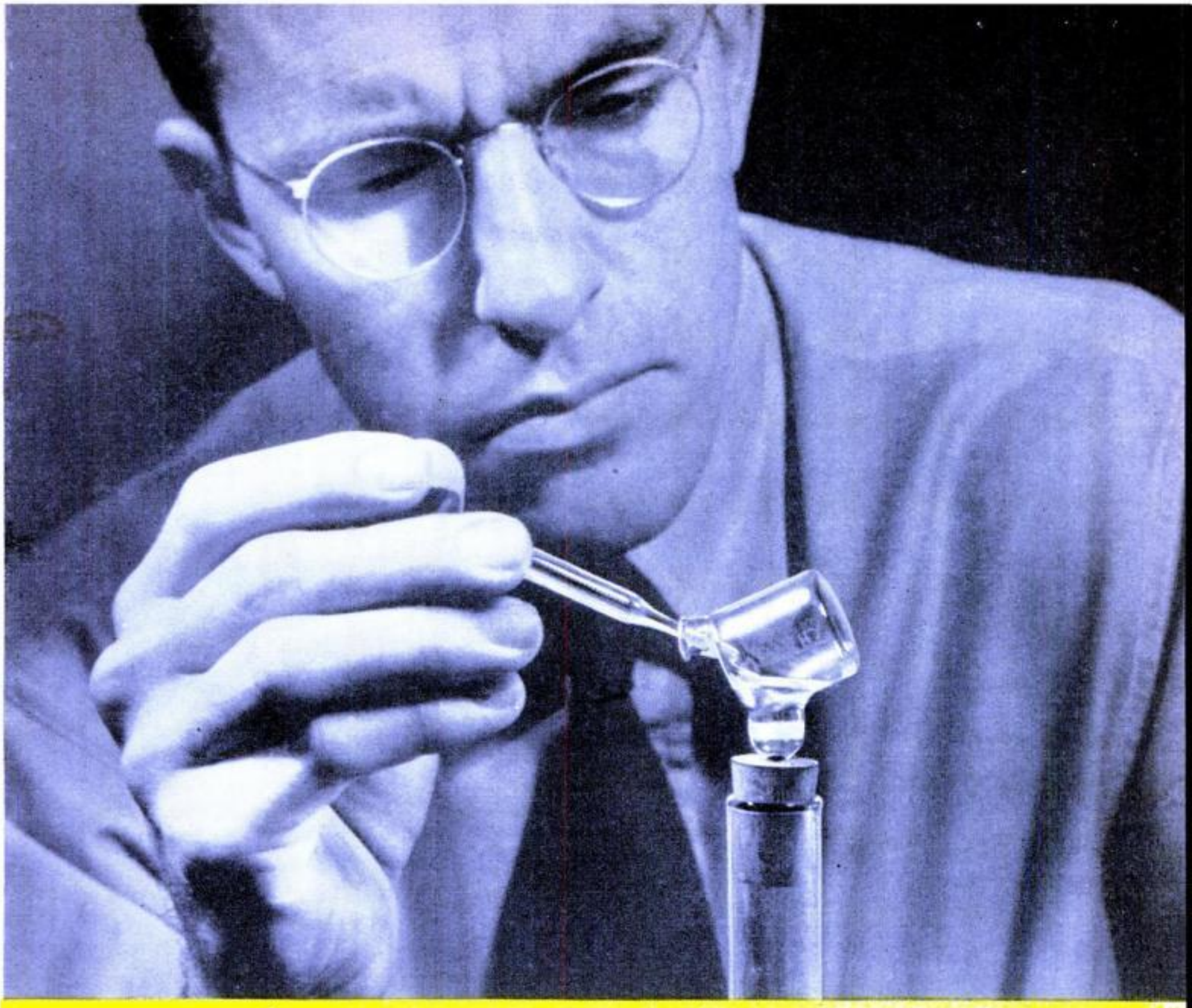


The microchemist, a Gulliver of modern science with Lilliputian equipment

Microchemistry

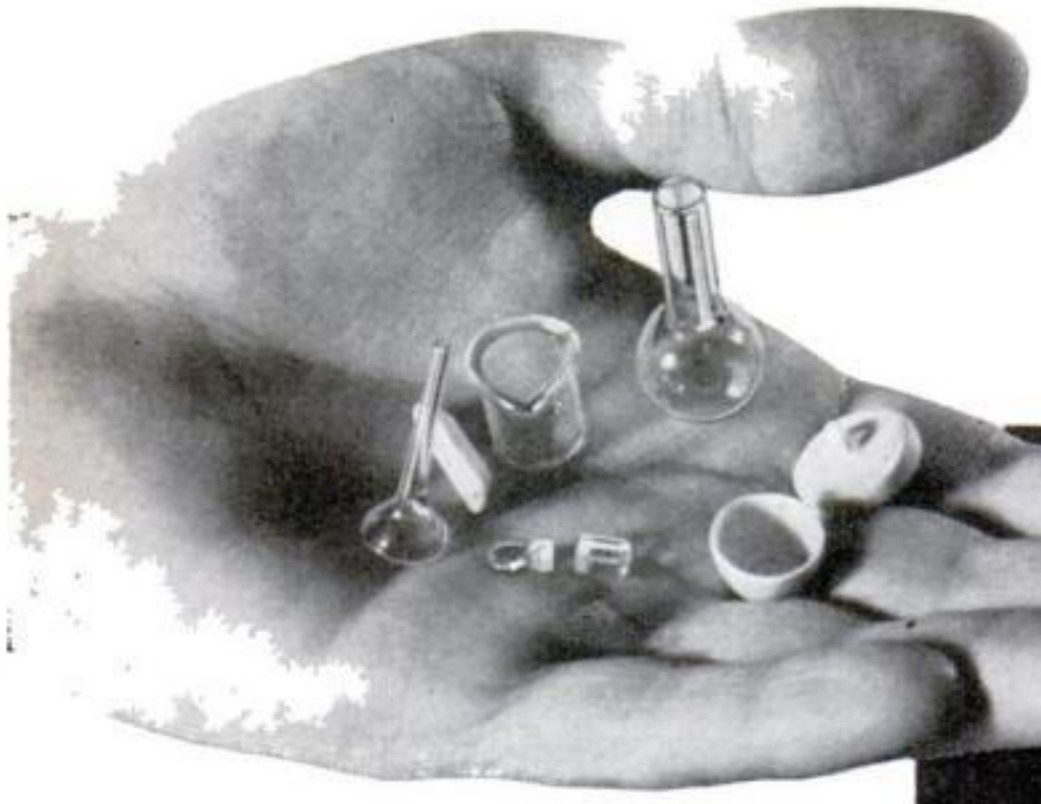
SOLVES BIG INDUSTRIAL PROBLEMS

By KENNETH M. SWEZEY

WORKING with pin-point quantities of materials, manipulated in thimble-sized beakers, flasks, and crucibles, microchemists of the Westinghouse research laboratories are solving big problems.

Analyzing coatings of common rust, corrosion, and tarnish, as well as monomolecular films of unknown composition, these experts in "vest-pocket" chemistry have in three years helped defeat more than a hundred invisible enemies that once marred the appearance and efficiency of electrical apparatus. From vacuum tubes in your radio to 1,000-ton electrical machines at Grand Coulee Dam, Westinghouse equipment has been benefited by microchemical discoveries.

Like a giant Gulliver towering above apparatus smaller than the tip of his little finger, Dr. E. Bruce Ashcraft, rangy, slow-spoken Texan, conducts this amazing laboratory. As a boy of 13, some 20 years ago, young Ashcraft found his first love for



Not toys—the funnel, beaker, bottles for dry and liquid weighing, crucible, and "boat" are real chemical apparatus

chemistry with a toy chemistry kit. Today, an industrial chemist of first rank, he pursues chemistry as a serious business, and with apparatus and amounts of chemicals far smaller than the toys of his childhood.

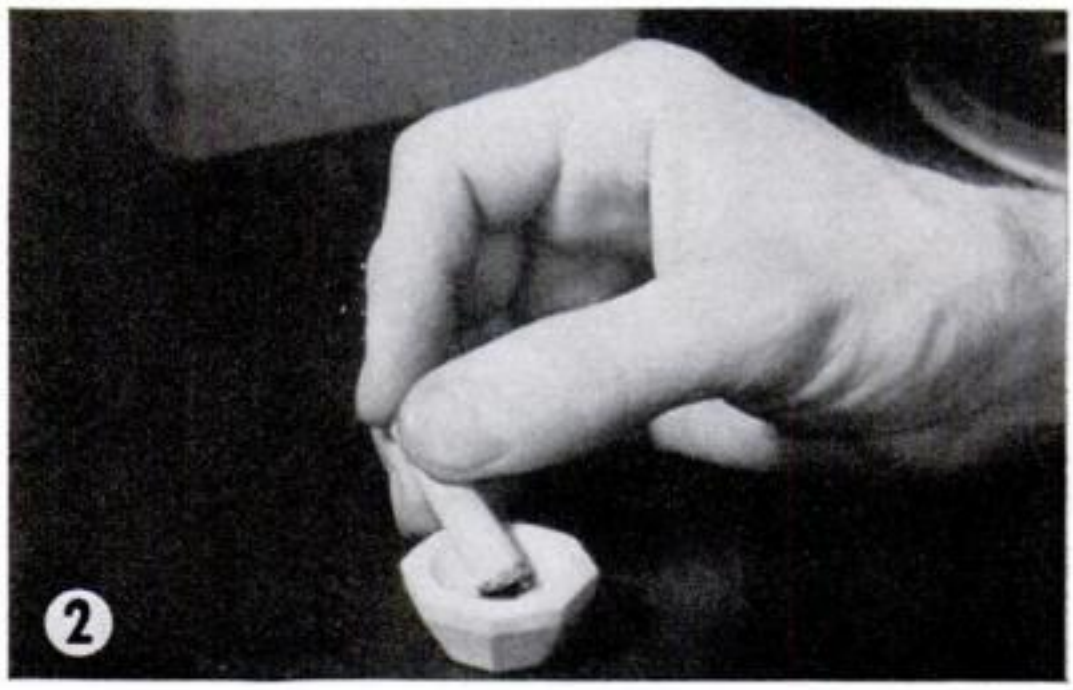
One of the tiniest pieces of apparatus is a weighing bottle, complete with ground-glass stopper, that holds just a few grains. Glass beakers range from the size of a pea to that of a small thimble. Porcelain "boats" and crucibles, in which chemicals are fused, run even smaller. Tiny retorts must be held over miniature flames by tweezers. Medicine droppers and capillary tubes with hair-breadth bores are used to apply reagents and transfer liquids.

Dealing in specks and grains, he watches many of the reactions under a magnifying glass or microscope. So small are the amounts conjured with that they are weighed on scales sensitive to one millionth of a gram—one forty-thousandth the weight of a drop of water, one sixty-thousandth that of a pin.

Modified only by the size of the specimens dealt with, no instrument or technique is barred. Microscope and spectroscope work hand in hand with beaker and balance. Sometimes electricity is called on for aid. By electrochemical means, for instance, copper weighing a millionth of a gram has been determined in a specimen weighing six millionths of a gram. As little as one twenty-fifth of a millionth of a gram of arsenic has been determined electrically.

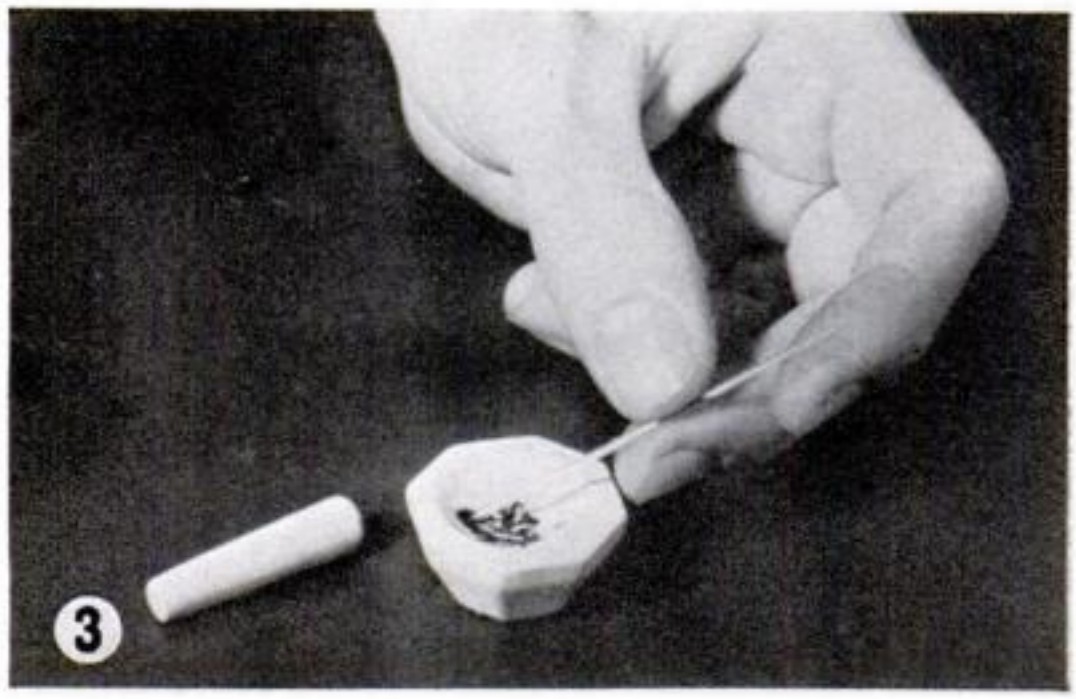
This laboratory of microscopic research meanwhile has become an important tool in industry, revealing the causes of electrical and mechanical trouble due to defects too minute to be analyzed or even detected by ordinary chemical means. Often films too small to see turn out to be oxides, sulphides, or chlorides produced by the atmosphere and causing current leakage in insu-

Scraping an insulator surface for particles of film to be analyzed in a trouble hunt by the microchemist



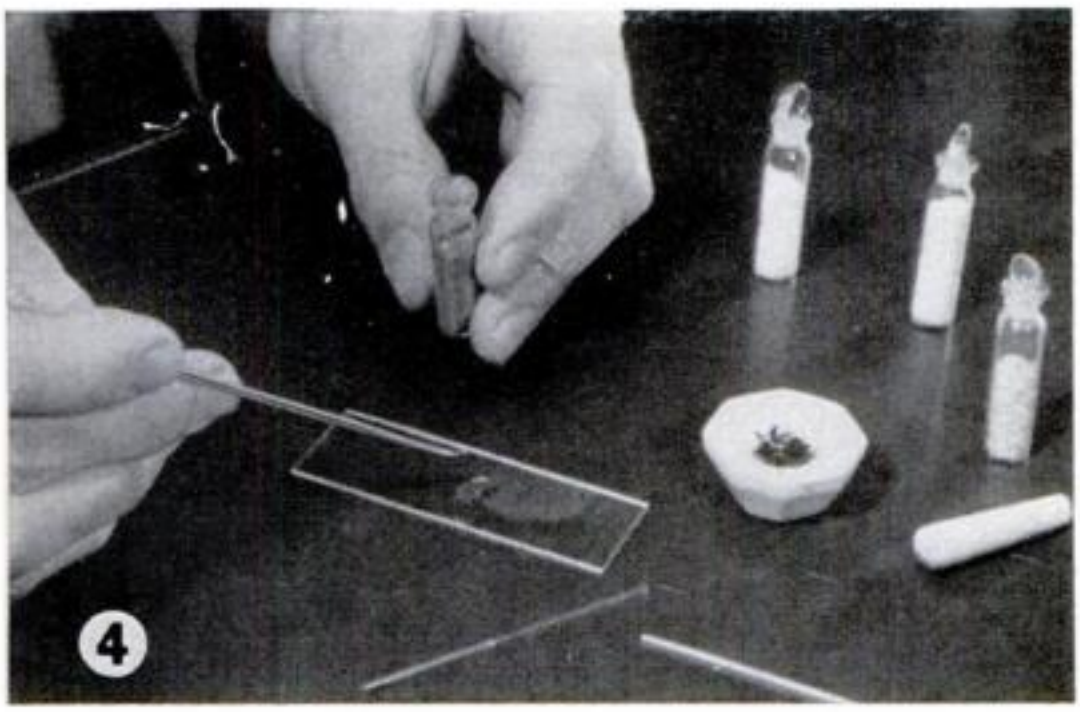
A baby pestle and a mortar the size of a thimble are used in grinding the scrapings of film still finer

Part of the powder is gathered in a capillary tube, and solvents are tried until the proper one is found

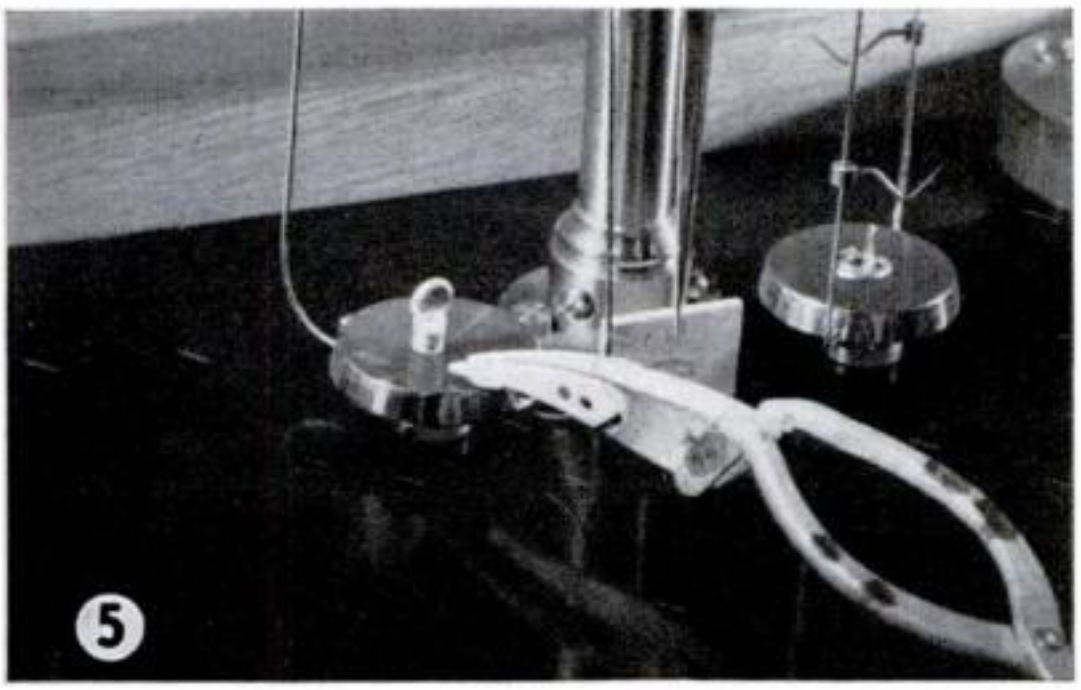


lators or partial insulation where perfect contact is essential.

In one especially noteworthy example, Dr. Ashcraft was called when radio engineers became puzzled by the falling off in efficiency of radio vacuum tubes. Ashcraft, suspecting minute amounts of silica, guarded against the presence of even microscopic particles of that substance in his reagents. Even the tiny amount dissolved from the glass of a bottle would have nullified his experiment. The water for his analysis was therefore stored in a platinum bottle. Tests on minute bits of filament showed that spots of silica had been splattered on them from the heated glass of the tube.

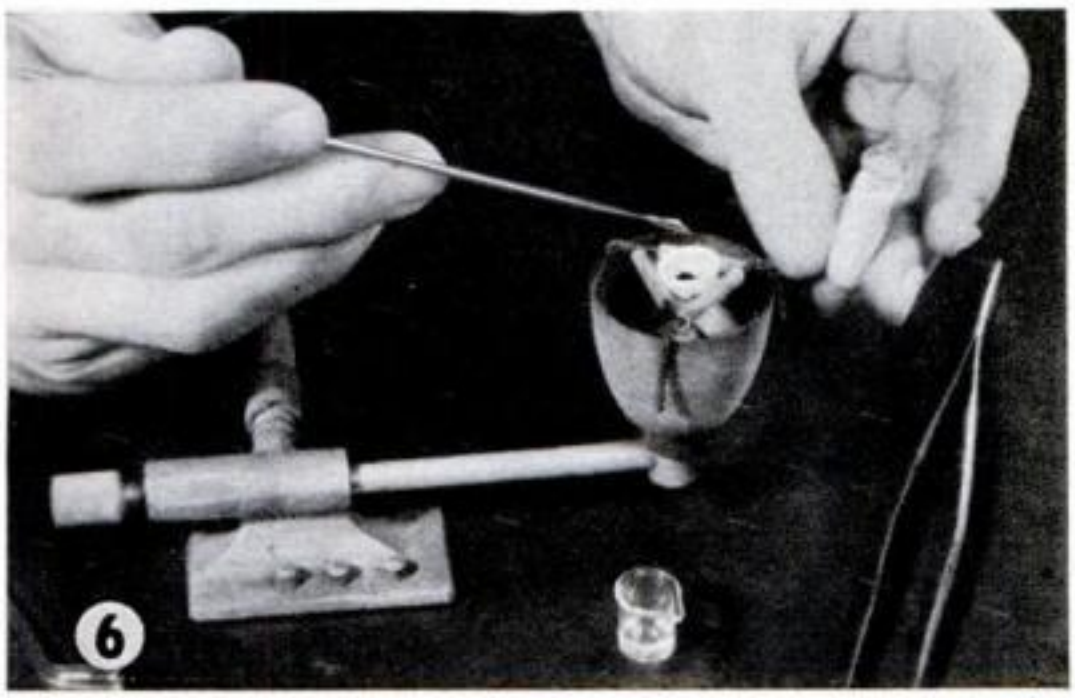


A drop of the solution is put on a slide. A reagent is added and identification made under a microscope

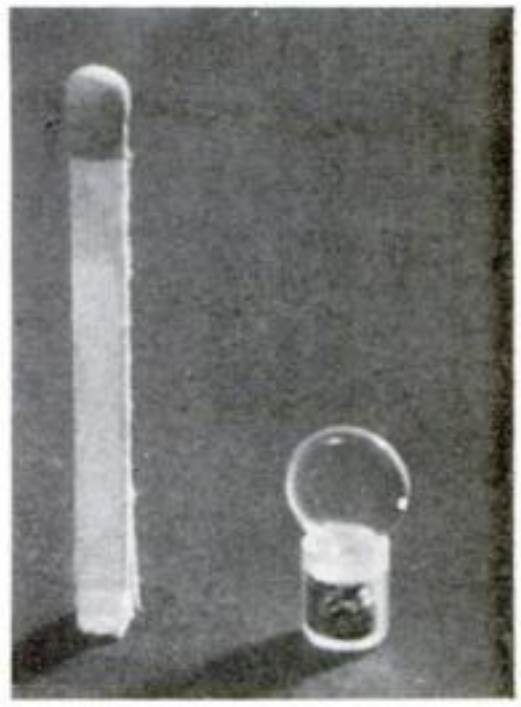


To find the amount present, grains are weighed in a bottle so small it must be handled with forceps

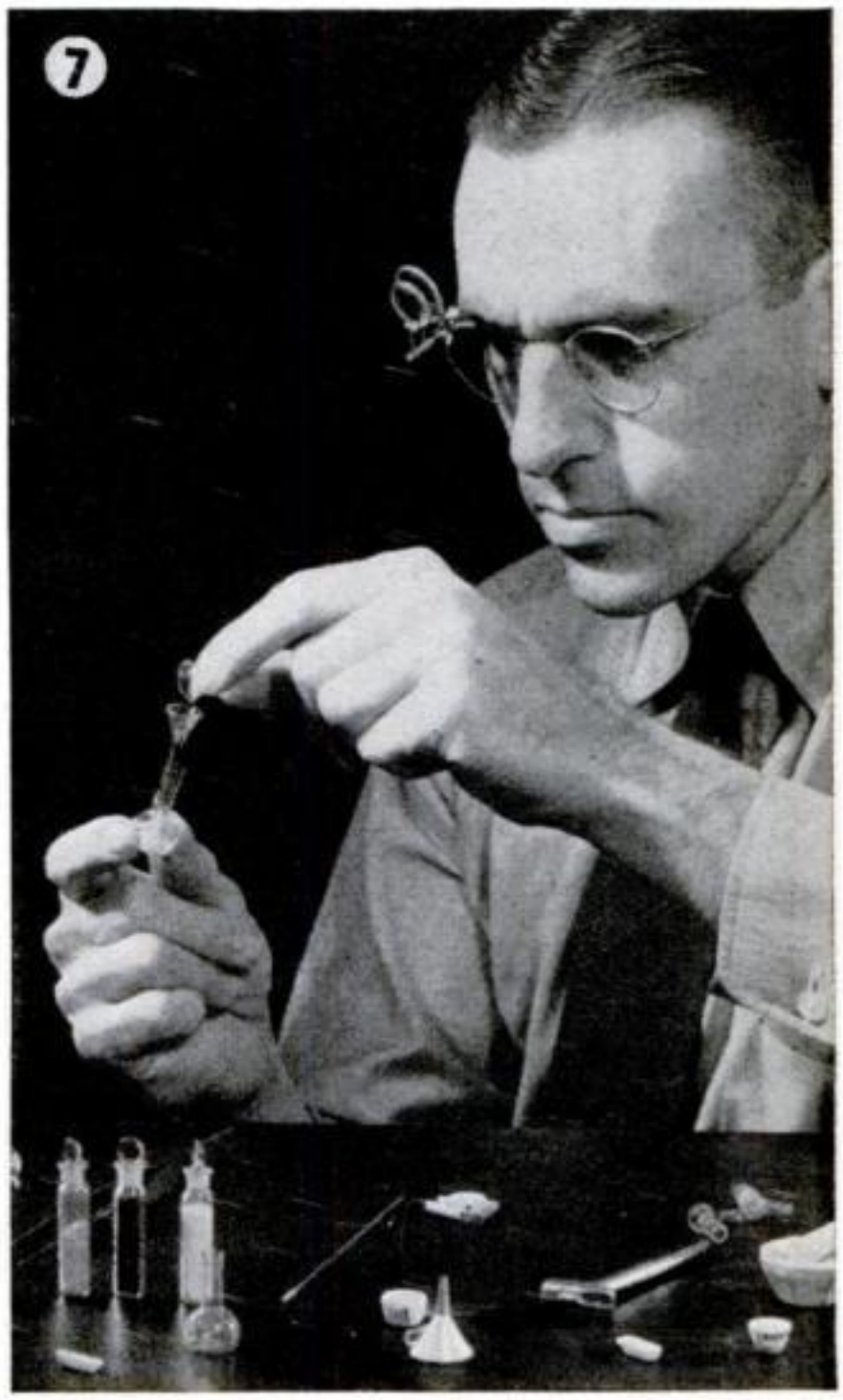
Carbonate is then mixed with the weighed dust in a tiny crucible and they are fused over a flame



One of the tiniest articles used in microchemistry is the bottle shown with an ordinary match at right. It is for precise weighing of dry particles which change in weight through exposure



The fused substance is dissolved in a reagent, put in a filter bottle, and then precipitated by another reagent. Dr. Ashcraft is shown as he washes the precipitate with distilled water. Now this is filtered, dried, and weighed again



HOW AMERICA IS USING HER *Fighter*

LOCKHEED P-38 "LIGHTNING" is one of our Army's twin-engine fighters designed for escort service and special missions. Armed with a 37-mm. cannon and four machine guns, it carries a crew of one or two men. For work at very high altitudes, it has turbo-superchargers

Ships

By CARL DREHER

HERE is a U. S. Army fighter plane—the Lockheed P-38—which, viewed from a certain angle, looks like three airplanes instead of one, until you see that it consists of a fuselage mounted between two slim engine nacelles and two sets of tail surfaces. Here is another—the Republic P-47B—packing about the same weight and wallop as the P-38, but utterly different in size and contour, with a single engine so large that it dwarfs the rest of the plane. And still others, some of more or less "conventional" design like the Curtiss P-40's, with the pilot sitting amidships behind the engine, or the engine in back of the pilot as in the Bell P-39C, or with pusher propellers like the Bell YFM. They differ in what can be seen and more in what cannot be seen—in armor, fuel tanks, superchargers, and auxiliary equipment—and yet every one of them is a U. S. Army fighter and nothing else.

Why should planes in the same general category, flown by the same service, show

With its tricycle landing gear and odd arrangement of central fuselage and twin engine nacelles, the P-38 presents a striking contrast to most other American fighter planes. The Army has one other twin-engine fighter, the Bell YFM-1A Airacuda. Weights of two-engine fighters are 11,000-14,000 pounds

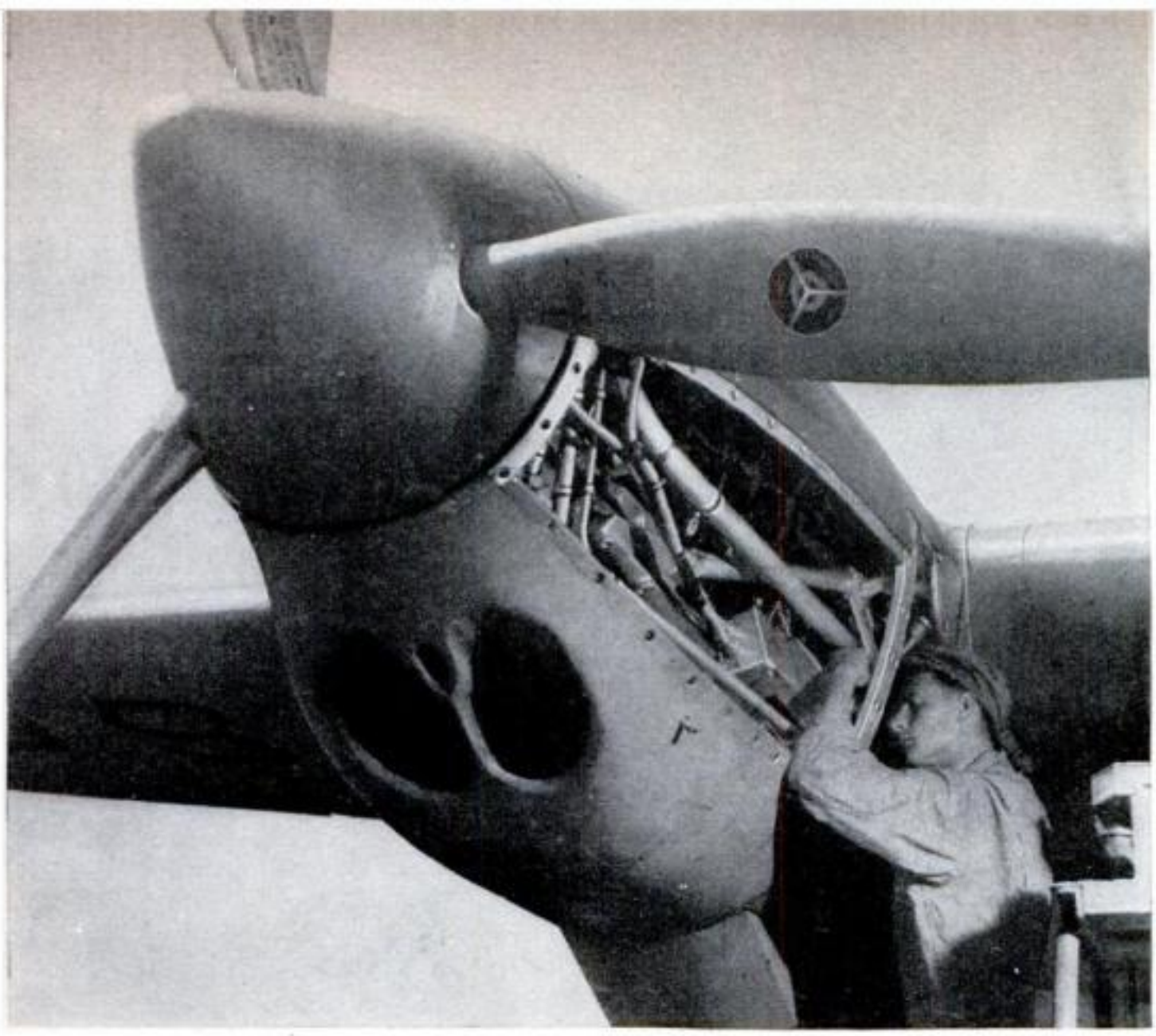
such variations in design? One reason is that development is proceeding at a very rapid pace, and a lot of good ideas are competing for supremacy. But a more compelling reason is the complexity of the problems which call for solution. After all, to say that a plane is designed to fight is pretty vague. When—by day or by night? Where—at 30,000 feet altitude or 3,000? Whom—is it to attack enemy bombers or protect friendly bombers? When such questions are asked it becomes evident that the fighter plane must be designed for one or two fairly specialized jobs.

When we survey existing models of fighters on this basis, a more or less logical pattern of design and development begins to emerge. There are three principal types of fighters on the basis of range. The interceptor is designed for operations close to its base. The pursuit plane for night fighting and extended day operations requires a considerably longer range, while heavy fighters for escort duty with bombers cover still greater distances.

First, the interceptor. The name indicates what its job is—to get off the ground on the shortest possible notice, climb with the greatest possible speed, and scare off or shoot down bombers, if possible before they can reach their objective. It is essentially a flying machine-gun nest—a small, highly maneuverable plane with a big engine. The engine must be big to get the plane up there fast and to give it the advantage over the bomber in speed—which, nowadays, calls for 400 m.p.h. and up.

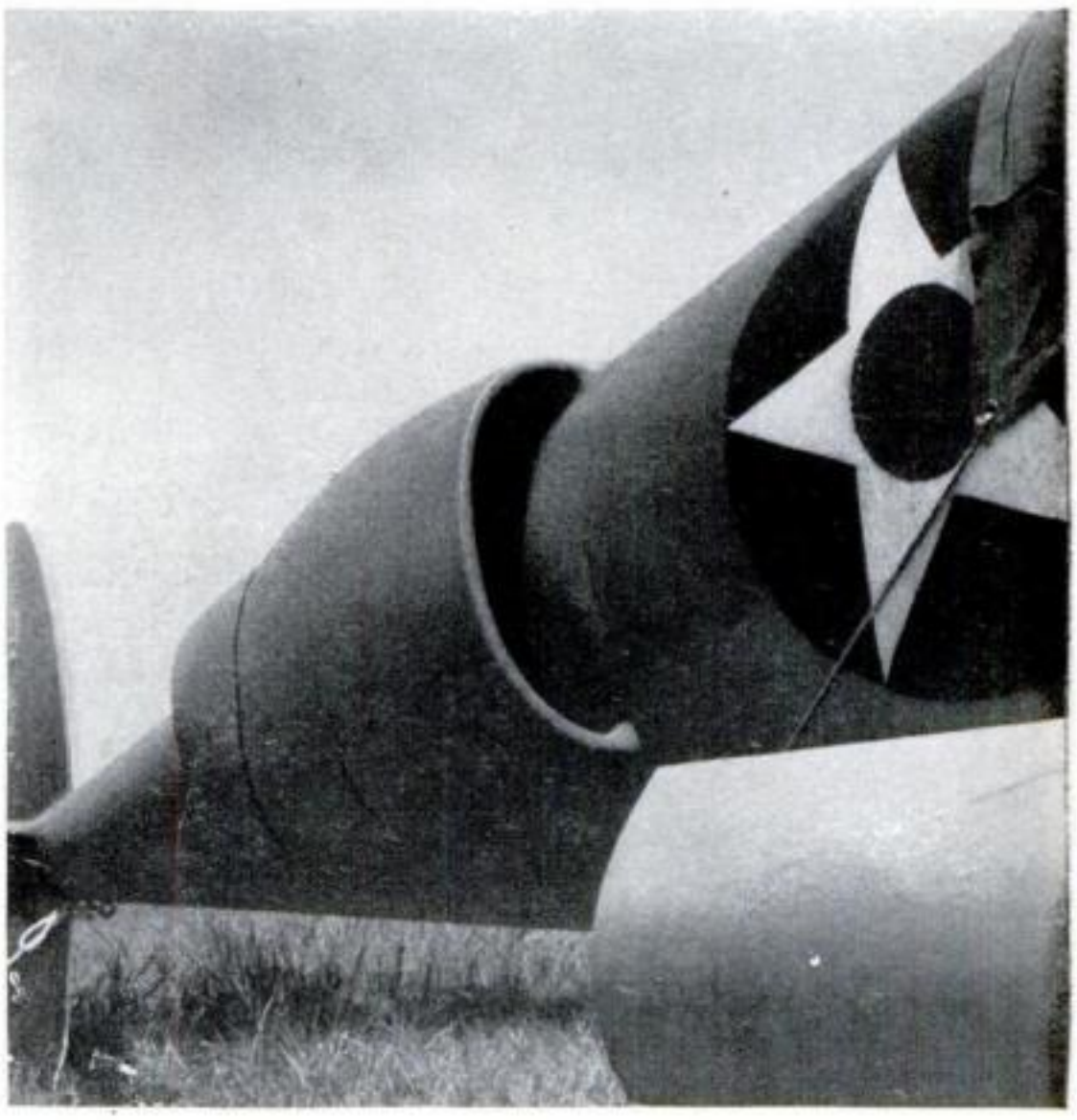
The interceptor is an inherently limited type of plane, capable of carrying only a few guns, no great amount of ammunition, only enough gas for a few hundred miles of flight, and one man to do all the work of piloting and shooting. For the interceptor pilot the motto is, If at first you don't succeed, give up and fly home. He just hasn't the ammunition or the fuel to do anything else. And there is no point in sending him up unless the general locality where he will meet the bomber is pretty definitely known. For all these reasons the interceptor is essentially a daylight weapon.

But because the interceptor can do deadly work when the conditions are right, bombers fly mainly at night. The night pursuit plane does not need the high maneuverability and top speed of the day interceptor. It is not going to engage in a dogfight. On the other hand, it needs much more gas capacity, for ordinarily it will take some time to find the bomber. For this purpose the night fighter is equipped with some form of long-range detection device. Even after the bomber is located and sighted, considerable stalking time must remain in the gasoline tanks. When the opportunity for the kill finally presents itself, the pursuit plane must close in and do the job quickly.



To counteract the heat from the liquid-cooled Allison engine, a big scoop on each tail boom drags in a hurricane of air. When the P-38 is used for observation, a camera is installed in one of the tail booms

One of the engine housings of a P-38. The holes underneath it are openings for an air scoop that cools the oil

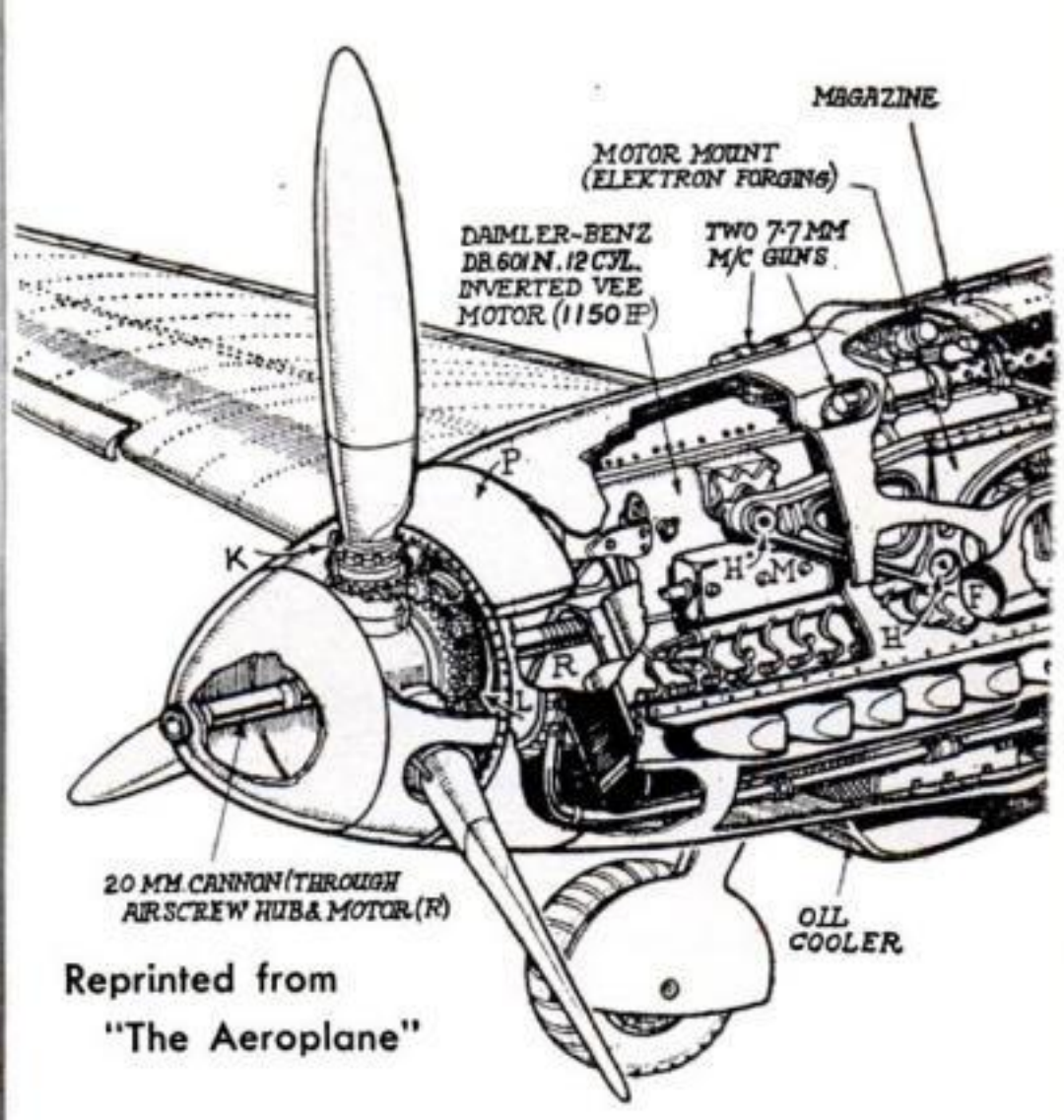


Day interceptors are almost always single-engine planes. For a given amount of power a single-engine plane is more maneuverable than a two-engine plane. Night fighters may have one engine or two. The multi-engine fighter may also be advantageously used in extended day pursuit operations. It carries considerable armament in the form of 20-mm. cannon or larger, and machine guns of .30 and .50 caliber. The crew normally consists of two men. Such planes are suitable for patrol work and long-range hunting, and also for escorting friendly bombers.

The design of fighter planes is conditioned as much by bomber performance as by the characteristics of other fighters. It is the bomber which works destruction on land and sea, and the ultimate function of the fighter is to down bombers. The fighter tackles an enemy fighter to put him out of the way so that he or someone else can get a whack at a hostile bomber or some similar flying objective.

The way in which bomber design affects fighter design is well illustrated by the application of superchargers, first to bombers, then to pursuit planes. A gasoline engine normally loses power as it gets into the rarefied atmosphere of the higher altitudes, where the cylinders gulp in less air for each piston stroke. This loss can be counteracted by increasing the size of the cylinders —to which there is a limit—or by supercharging. The original Boeing Flying Fortress had a top speed of 250 m.p.h. at 13,000

GERMANY'S MESSERSCHMITT ME-109.
At left matched with comparable Allied planes, our P-40 and the British Spitfire



Reprinted from "The Aeroplane"

Span	33 ft. 0 in.	Length	29 ft. 8 in.
Wing Area (net)	164 sq. ft.	Track	7 ft. 0 in.
Weight Empty	4,740 lbs.	Weight Loaded	6,000 lbs.

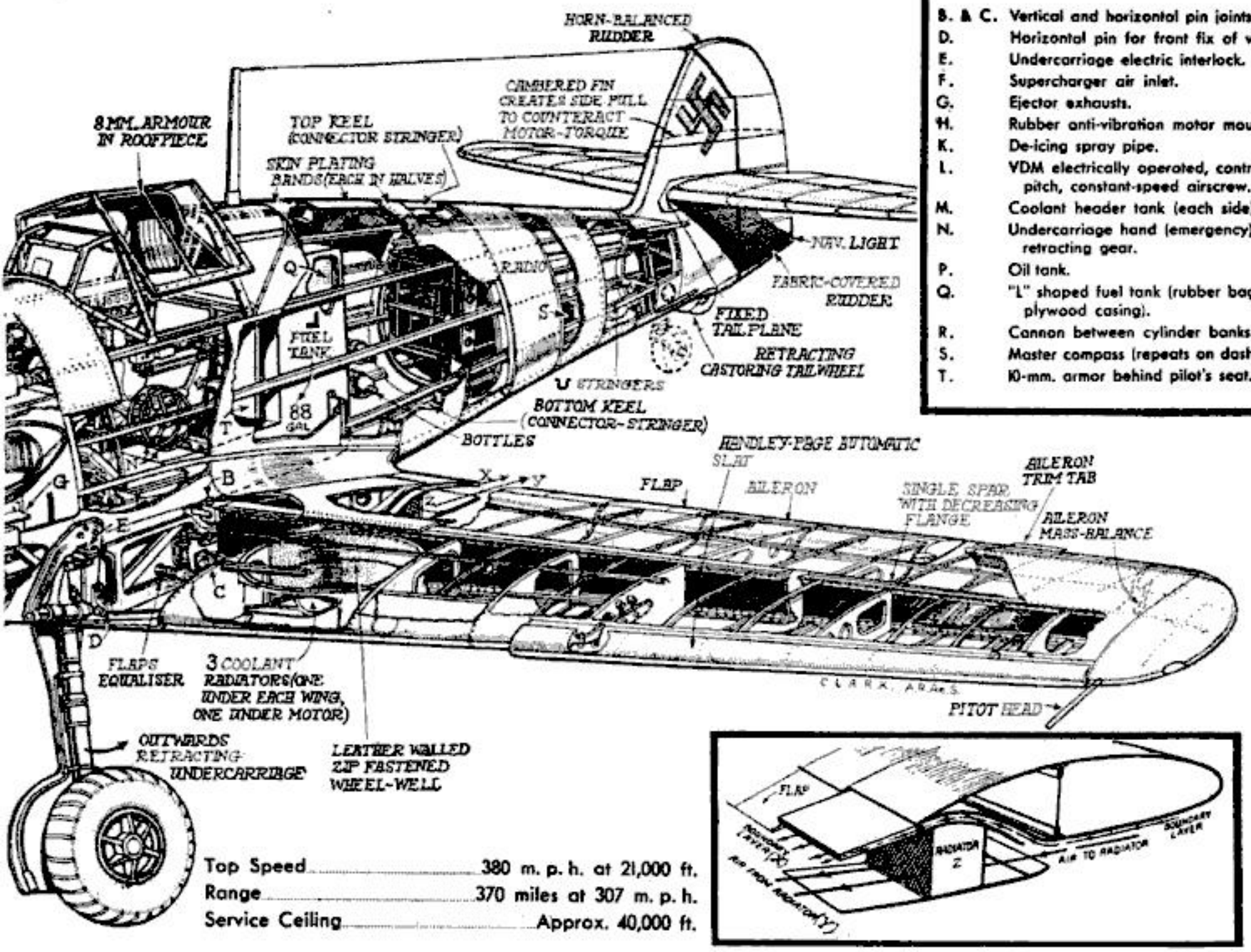
feet with its four motors wide open. With the same motors supercharged, it is good for more than 300 m.p.h. at 20,000 feet, and it can cruise comfortably at 245 m.p.h. at 30,000 feet. The same thing must be done for fighters intended to operate at high altitudes, but it is harder because of limited space and weight allowances.

With the above considerations in mind we can discern the general design pattern of our current Army fighter models. Almost all the types to be described have proved their merits in actual combat. Naturally some are better than others. A few will fall by the wayside, others will undergo further development. Later models will be quite different from their prototypes, and a lot better.

Typical of the one-engine, one-seat fighters designed for sea-level operation—which means between sea level and an altitude of about 20,000 feet—are planes like the Bell P-39 Airacobra and the Curtiss Hawk line. The P-39C is powered by a 12-cylinder, 1,150-h.p., liquid-cooled Allison motor which drives a three-bladed tractor propeller through a 10-foot extension shaft. Landing gear is of the tricycle type. The armament consists of a 20-mm. cannon in the propeller hub, as well as light and heavy-caliber machine guns. The weight of the plane, loaded, is 7,380 pounds, this includes sufficient ammunition for fairly sustained fire. The range at the most economical cruising speed is 1,100 miles, which is very good. A plane with these characteristics is more than a match for the equivalent Messerschmitt, the Me-109F, and approximately equal to the British Spitfire. But only up to about 16,000 feet.

The later Curtiss Hawks are designed for somewhat higher ceilings. The current model stems from the original P-36, through the P-37 and the more highly streamlined P-40D and E. The earlier P-40's compared favorably with the older Spitfires and Hurricanes; the latest type is believed to equal or excel any of the European fighters. Increases in speed and high-altitude performance have been achieved in spite of greatly increased armament, ammunition loads, and armor plate.

U. S. Army fighters specifically designed for high-altitude operations —between say 16,000 feet and the present effective ceiling of about 35,000 feet—include the Republic P-43F Lancer and the same company's P-47B Thunderbolt. The P-43F is powered with a Pratt & Whitney Twin Wasp 1,200-h.p. air-cooled engine. The loaded weight is slightly less than that of the Airacobra—6,900 pounds. Armament consists of large



Top Speed	380 m. p. h. at 21,000 ft.
Range	370 miles at 307 m. p. h.
Service Ceiling	Approx. 40,000 ft.

and small-caliber machine guns. The companion Republic pursuit plane, the P-47B, is at present the most powerful of American single-engine, single-seater fighters. The motor is a 14-cylinder, 2,000-h.p. Pratt & Whitney radial, driving a four-blade propeller. High-altitude performance is obtained by means of a turbo-supercharger. This plane is said to have reached a speed of 680 m.p.h. in a power dive.

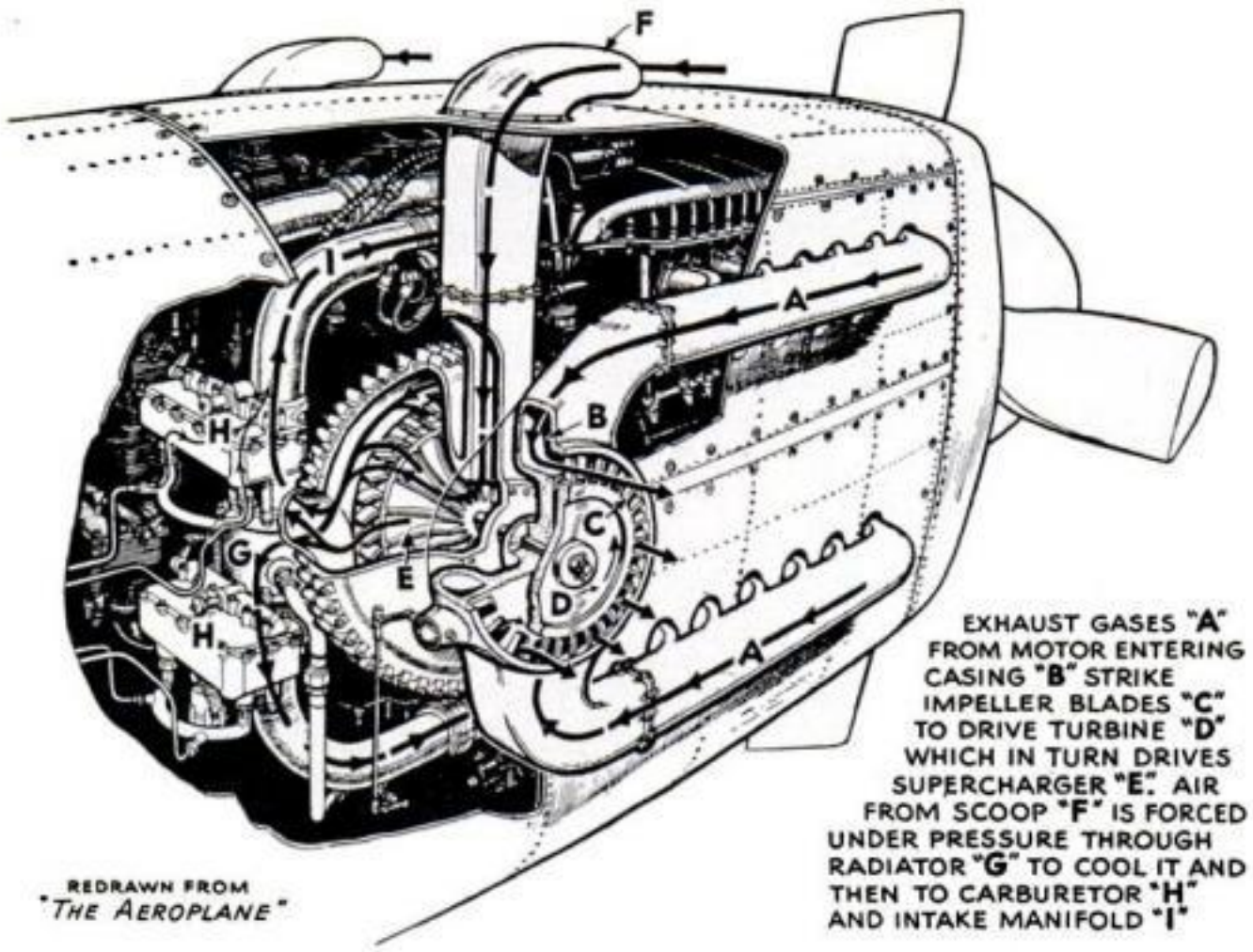
The U. S. Army has two twin-engine fighters for escort service and special missions. One is the Lockheed P-38 Lightning and the other the Bell YFM-1A Airacuda. Both are armed with cannon and machine guns. The P-38 is the faster of the two, while the YFM has much the greater range —some estimates run as high as 3,000 miles. The P-38 carries a crew of one or two, the YFM a crew of five. For high-altitude service these heavy fighters are equipped with turbo-superchargers. Weights of two-engine fighters run around 11,000-14,000 pounds, as compared with 6,000-8,000 pounds for single-engine fighters.

The U. S. Navy uses air-cooled engines for its carrier-based fighters. Such planes must be equipped with arresting hooks which engage horizontal cables on the carrier deck to bring the plane to a quick stop in landing. This calls for stronger and heavier undercarriages. The wings of some of the later types fold so that more planes may be accommodated in a given deck space. Gasoline capacity is at least 50 percent higher than in land-based planes of the same type. In spite of these handicaps, naval fighters are nearly as fast as the equivalent Army aircraft and the service ceilings are about the same.

Principal naval fighters are the Brewster Buffalo (F2A) and Grumman Wildcat (F4F). The latest model of the latter, the F4F-3, is a single-place monoplane powered with a 1,200-h.p. Pratt & Whitney air-cooled twin-row engine. Its cruising range is about 1,000 miles. Most efficient operation is at 20,000 feet. Normal armament consists of four .50 caliber machine guns. For light dive-bombing operations two 11-pound bombs may be carried. This plane is said to have been dived at over 500 m.p.h., but another Navy fighter, the Vought-Sikorsky Corsair, F4U-1, is even faster. The Navy also has an experimental two-engine fighter, the Grumman Skyrocket (XF5F-1).

It is interesting to compare these American fighter planes with European models. The German Messerschmitt Me-109F is in the same class as our latest P-39's and P-40's. It is powered with a 1,150 h.p. Daimler-Benz DB-601N motor, liquid-cooled

and supercharged for a 40,000-foot service ceiling. The speed is 362 m.p.h. at 13,000 feet, and 380 m.p.h. at 21,000 feet, the latter being the top speed. Range is 370 miles at 307 m.p.h. (1.2 hours), and 600 miles at 262 m.p.h. (2.3 hours). The principal novelty of this fighter is a Mauser 15 or 20-mm. cannon firing 900 rounds per minute—just below the normal rate of fire of a modern machine gun. Loaded, the plane weighs 6,000 pounds. It is said to have been especially designed for dogfights and admittedly has a faster climb than the British Spitfire, but the latter has shown better maneuverability in encounters.

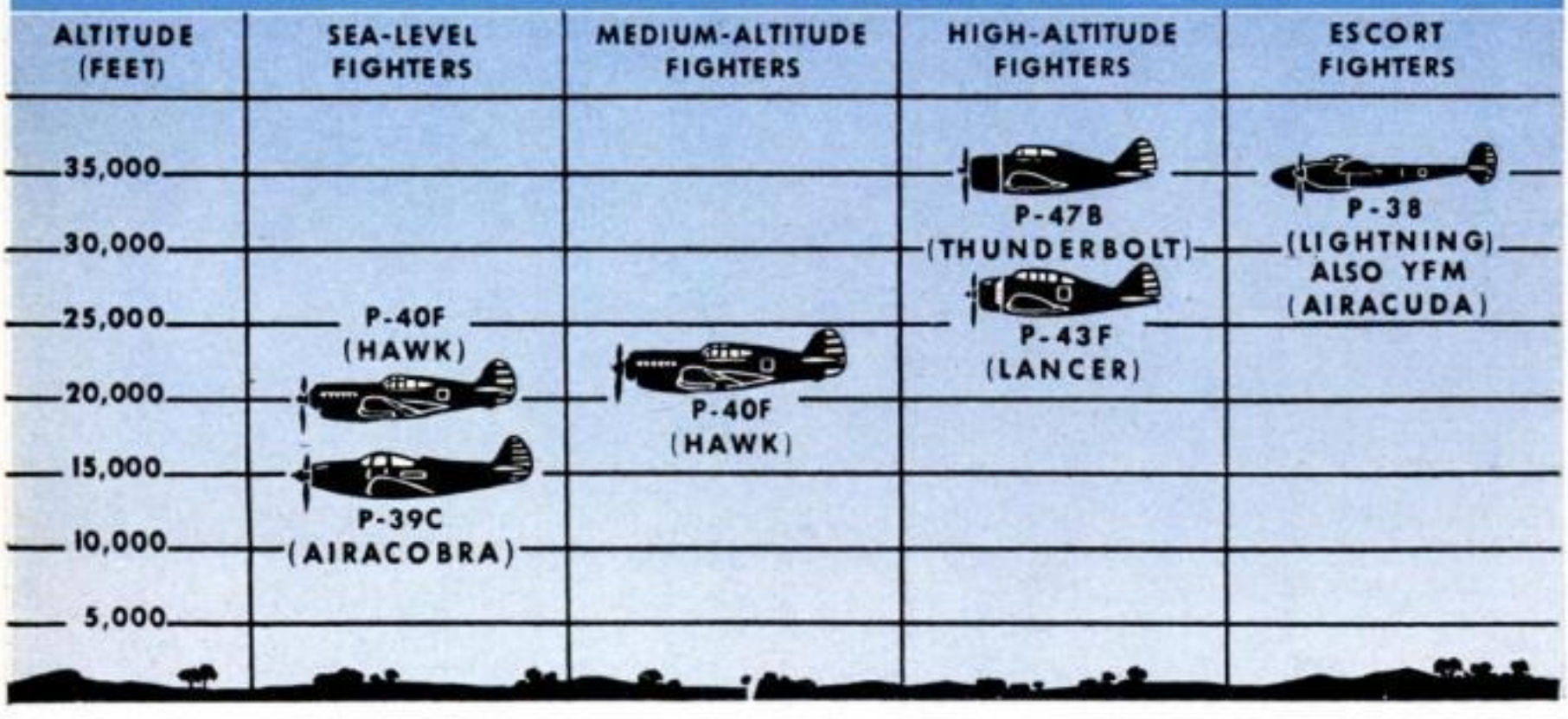


This idealized drawing shows how the turbo-supercharger works. Engine exhaust gases drive a turbine which operates a blower to raise air pressure at intake

The British Beaufighter I is a two-engine, two-place fighter adapted from a medium bomber. Each engine is rated at 1,400 h.p. The armament is very heavy—four fixed cannon in the fuselage and six fixed machine guns in the wings. The maximum speed is fair—330 m.p.h., and the service ceiling is 29,000 feet. The opposing German fighter, the twin-engine Me-110, has a higher top speed—365 m.p.h. Another German twin-engine fighter, the Focke-Wulf FW187, with about the same maximum speed (at 20,000 feet) is said to have a service ceiling of 39,000 feet. Equivalent American two-engine fighters like the Lockheed P-38 are believed to be superior in speed, climb, and hitting power.

The designer of a modern fighter plane strives for maximum speed, power and altitude performance, maneuverability, fire power, and armor protection. Speed, to prevent the enemy fighter or bomber from escaping by diving or straight flight. Power, to prevent the enemy from escaping by zooming, and maneuverability so that he cannot elude his pursuer by a sudden change

HOW AMERICA'S FIGHTER PLANES STACK UP



Said to be the world's fastest single-engine craft, the Republic P-47B has a 2,000-horsepower Pratt & Whitney radial 14-cylinder power plant that dwarfs the rest of the plane. One man flies and fights it

in direction. Fire power is vital so that the enemy may be put out of commission in the few seconds of close engagement. Since the enemy has exactly the same purpose, the best possible armor protection must be provided.

Almost all the basic factors—speed, power, altitude performance, weight, etc. are tending to rise. Speeds are or will soon be between 400 and 450 m.p.h. at altitudes between 20,000 and 35,000 feet. This means that the airplane must be as small as possible to reduce drag. Weights, nevertheless, are increasing because of ordnance, armor-protection, and engine requirements.

Supercharging is essential for efficient operation at high altitudes. Two general types of superchargers are at present available—centrifugal blowers or compressors gear-driven by the engine, and turbo-superchargers which utilize the exhaust gases to drive a turbine wheel which in turn drives the compressor. The geared superchargers are simpler, but they work well only at the middle altitudes.

The propeller presents a similar problem. A propeller which may be satisfactory at sea level and under take-off conditions will have entirely unsatisfactory propulsive efficiency at high altitudes and high speeds. A propeller suitable for a medium-powered engine will not work with a larger engine. The propeller tip speed can be increased only to a given point, and of course the diameter is limited by structural considerations. Consequently the tendency is toward a greater number of blades.

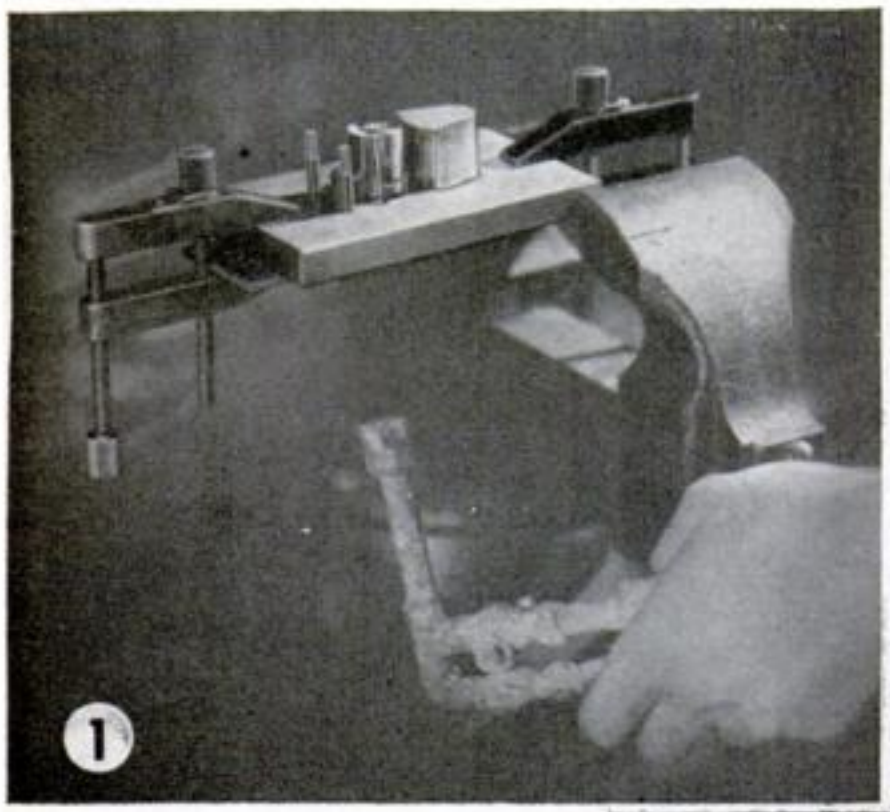
Modern propellers for high-altitude flight must be equipped with pitch control. Between take-off and terminal-velocity dive the pitch range may have to be as high as 40 degrees. The pilot cannot attend to it; he has too many other things to do. Automatic pitch-control devices are mandatory.

Protection and fire power seesaw in the air as in battleship design. Bigger guns call for thicker armor, thicker armor calls for bigger guns, but guns and ammunition add weight and cut down speed. Again the solution is by compromise—the continued installation of both .30 and .50 caliber machine guns on fighters is one example. At first .30 guns were adequate. Heavier armoring brought .50 guns and cannon.

Small cannon are valuable when the pursuit plane tackles a bomber. Aerial engagements with machine guns must be fought at close quarters, usually not exceeding 300 meters. On the other hand, a pursuit plane armed with a cannon can damage a bomber and sometimes bring it down, without coming within the effective fire area of the bomber's machine guns.

Radical developments in future fighter designs are possible, even probable. Perhaps the most rapid progress may be expected in night fighting and in what may be called engineering the pilot for combat at high altitudes. In wartime these and other matters are best left to the imagination. The enemy will find out about them in due course, but he will have to get the information in the air, and, we may hope, at a high cost.

Poured Matrix Alloy Speeds Die-Making

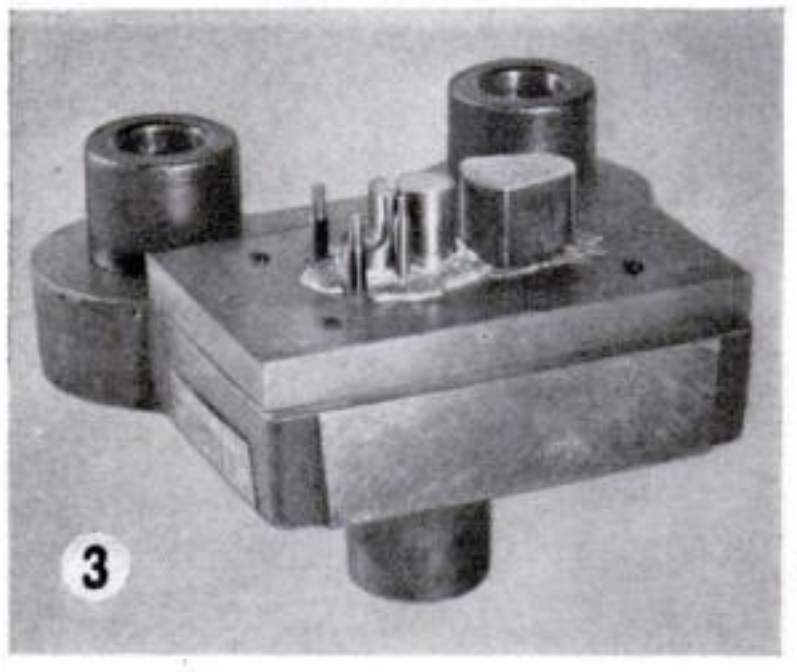


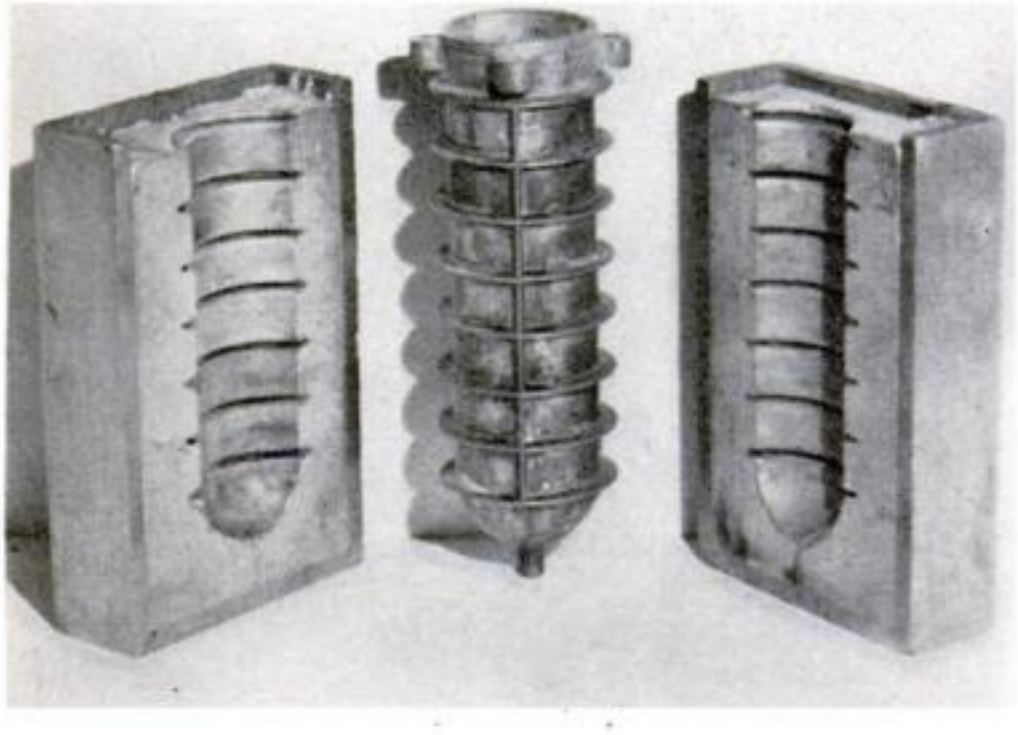
1 Preparing to make a die. Punches are held by screws supported by a temporary plate under the holding punch plate. Both plates are heated

2 Molten alloy is poured around the punches to secure them in place. Once requiring precise machining, this is done by a semi-skilled worker

LIGHTNING-FAST as our mechanized armies roll, the redesigning and change-over of tools on the war production lines must move even faster. Bottlenecks must be broken, much in the way that a new low-melting matrix alloy, bismuth, lead, tin, and antimony, has eliminated barriers in the construction of metal dies and chucks.

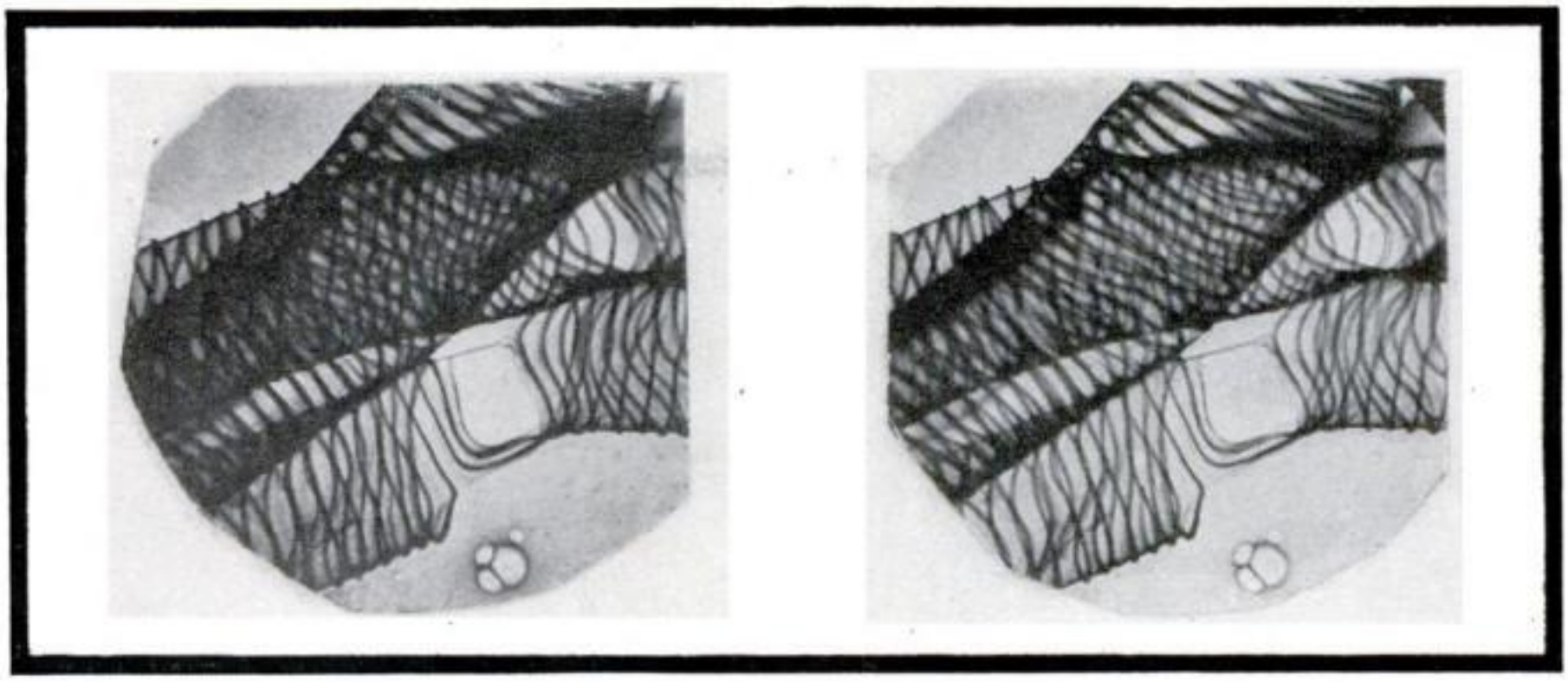
Heretofore, dies and punches had to be machined from solid metal or secured to the holding plate with complicated devices. Today, this alloy releases machines for other war jobs. A semi-skilled workman, after the punches have been aligned, can pour the molten metal. When hardened, it will withstand pressure of 8,000 pounds to the square inch.





3 With the punches fastened firmly to the holding punch plate by the poured alloy, the hardened die base is attached and the die is ready to go into service

Among applications of the matrix alloy is the casting of chuck jaws, such as shown at left, to hold bits of metal while they are being machined. A simple wooden mold made in two sections is clamped around the object to be held, and the alloy poured in



Stereo electron micrograph of a mosquito larva's trachea. Place a card with one edge between the two photographs and the other edge between your eyes, and try to get the three-dimensional effect

Stereoscopic Photos with Electron Microscope

THREE-DIMENSIONAL pictures of the submicroscopic world are now possible by means of the powerful RCA electron microscope. An ingenious photographic technique, which employs a rotating specimen holder, gives a stereoscopic quality to images on the micrograph.

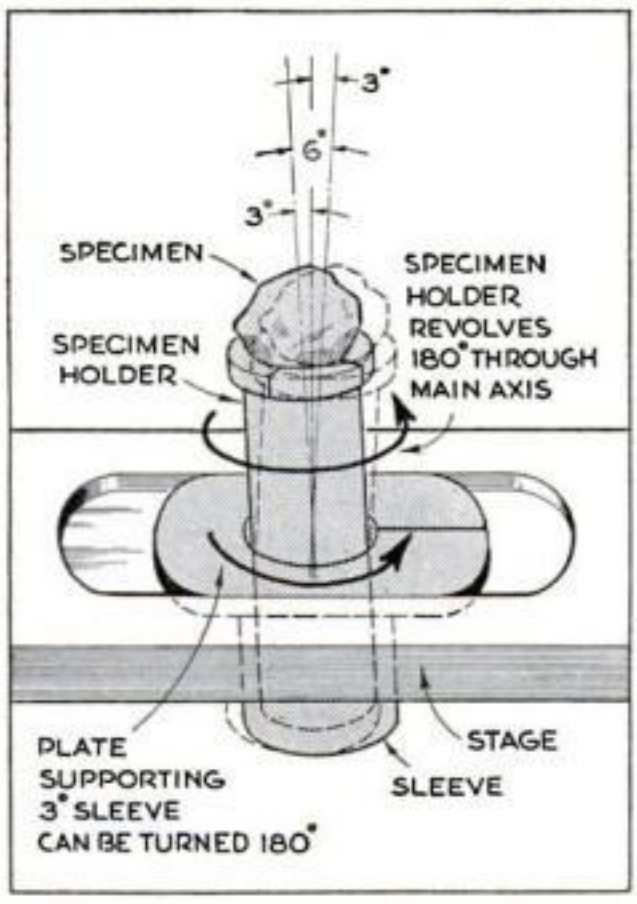
Scientists, looking at tiny objects magnified as much as 100,000 times, will now have the added advantage of seeing the object with the effect of depth. This will enable them to judge better its over-all size and shape, and the relation of its many parts.

To get the three-dimensional quality, two pictures are taken in succession. The specimen is fixed on a special rotating holder which fits in a removable sleeve. The sleeve is tilted at an angle of three degrees, which keeps the specimen slightly off-center from the camera lens. After the first picture is taken, the sleeve is turned around to face in the opposite direction. This turns the specimen so that it is three degrees off-center to the other side of the camera lens. The specimen holder must also be turned 180 degrees in the same direction to keep the image facing in the same direction on the film. When the two pictures are printed, they can be viewed in a stereoscope to get the proper three-dimensional quality.

Entomologists are making a special study with the electron microscope in an effort to find out heretofore undisclosed facts about insects' breathing equipment. It has been found that cockroach skin is made up of many layers, including a thin outer layer of continuous water-repellent material, a thicker continuous layer, and a thick layer of laminated material through which pass tiny pore canals. These canals, averaging about a six-millionth of an inch long, were thought to be present but were definitely confirmed for the first time with the electron microscope.

Two scientists recently showed micrographs, taken with the electron microscope, of insect tracheae, butterfly scales, and beetle elytra to illustrate the minute anatomical details found in different insects. Some of the micrographs shown illustrated details that were four ten-millionths of an inch in magnitude.

With the new stereoscopic technique in photographing specimens, the electron microscope is expected to open up new vistas in many widely separated fields of science and industry.



Rotating specimen holder used in making stereo electron micrographs

Here's My Story

LT. GEN. DELOS C. EMMONS WAS BORN IN HUNTINGTON, WEST VIRGINIA, IN 1888

ENTERING WEST POINT IN 1905, CADET EMMONS, A HANDSOME, WELL-BUILT LAD, BONED HIS WAY THROUGH THE ACADEMY AND DISTINGUISHED HIMSELF AS A TRACK MAN IN THE 100-YARD DASH

AFTER GRADUATION, HE WAS ASSIGNED TO THE 30TH INFANTRY AT SAN FRANCISCO AND SHORTLY AFTER TO FORT GIBBON, ALASKA, WHERE HE MADE SUCH ACCURATE SURVEYS THAT SOME MAPS ARE STILL BASED ON HIS FINDINGS

IN 1917, AS A CAPTAIN, EMMONS WAS TRANSFERRED TO THE 37TH INFANTRY AT SAN DIEGO, CALIF. STATIONED NEAR THE SIGNAL CORPS AVIATION SCHOOL, HE DEVELOPED A KEEN INTEREST IN AVIATION

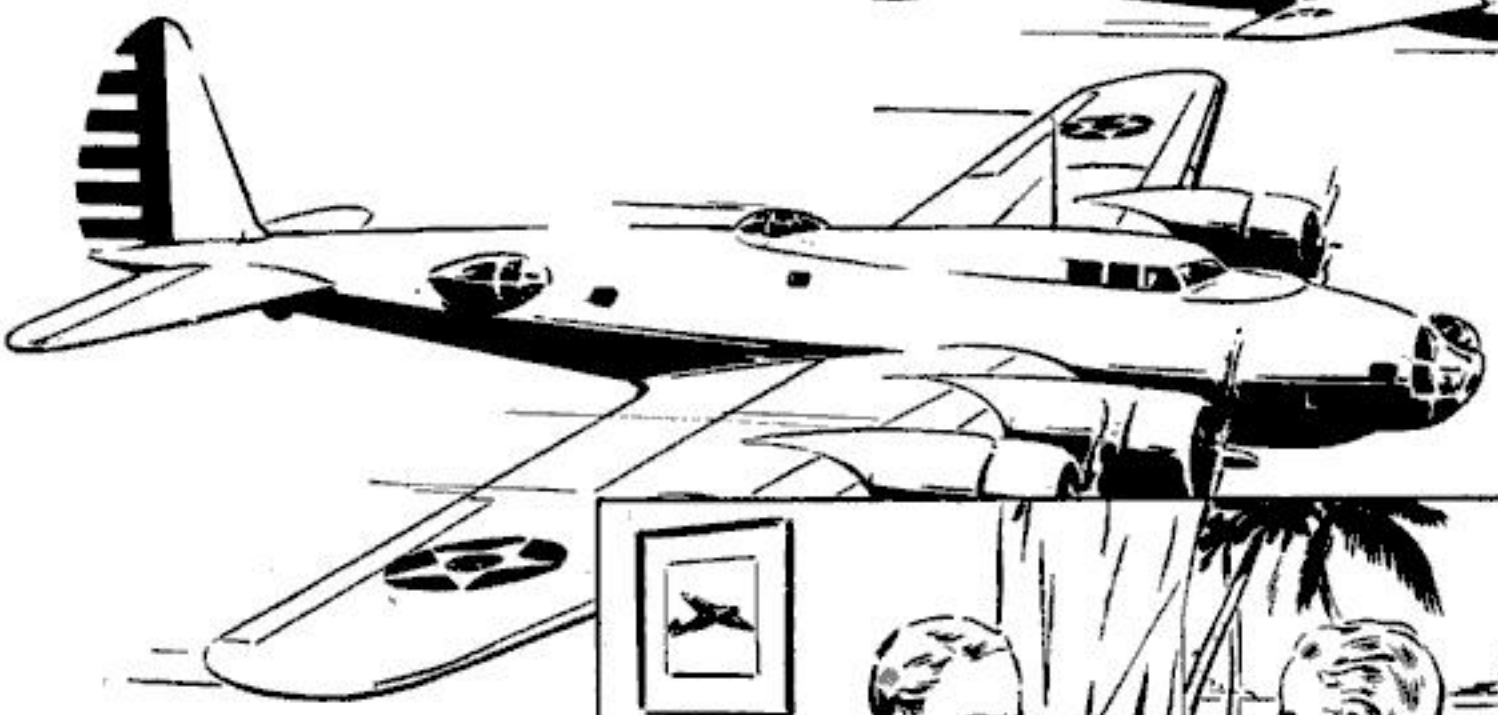
AIR CORPS MEDICAL EXAMINERS TURNED HIM DOWN THREE TIMES BECAUSE HE COULD NOT HEAR A WATCH TICK. ON THE FOURTH TRY THE MEDICAL OFFICER EXCLAIMED, "HELL, YOU CAN'T HEAR ANYTHING IN A PLANE ANYWAY—YOU'RE PASSED!"

ALWAYS A HARD WORKER, EMMONS WAS PROMOTED AND GIVEN COMMAND OF SEVERAL AVIATION POSTS. IN 1934 HE WAS GRADUATED FROM THE GENERAL STAFF SCHOOL AND SENT TO FORT SHAFTER, HAWAII, TO COMMAND THE 18TH COMPOSITE WING

THE CAREER OF LT. GEN. DELOS C. EMMONS

7 AS A SPECIAL OBSERVER FOR PRESIDENT ROOSEVELT, LIEUTENANT GENERAL EMMONS HAD A RINGSIDE SEAT DURING THE AERIAL BATTLE OVER BRITAIN IN 1940. IN CONSTANT DANGER, HE PREPARED A SECRET REPORT FROM THE FRONT LINES

6 IN 1939 MAJOR GENERAL EMMONS LED SEVEN FLYING FORTRESSES ON A 10,000-MILE GOOD-WILL FLIGHT TO BRAZIL. THE LAST LEG OF THE TRIP, FROM MARACAIBO, VENEZUELA, TO BOLLING FIELD, COVERED 2,150 MILES WITHOUT A STOP



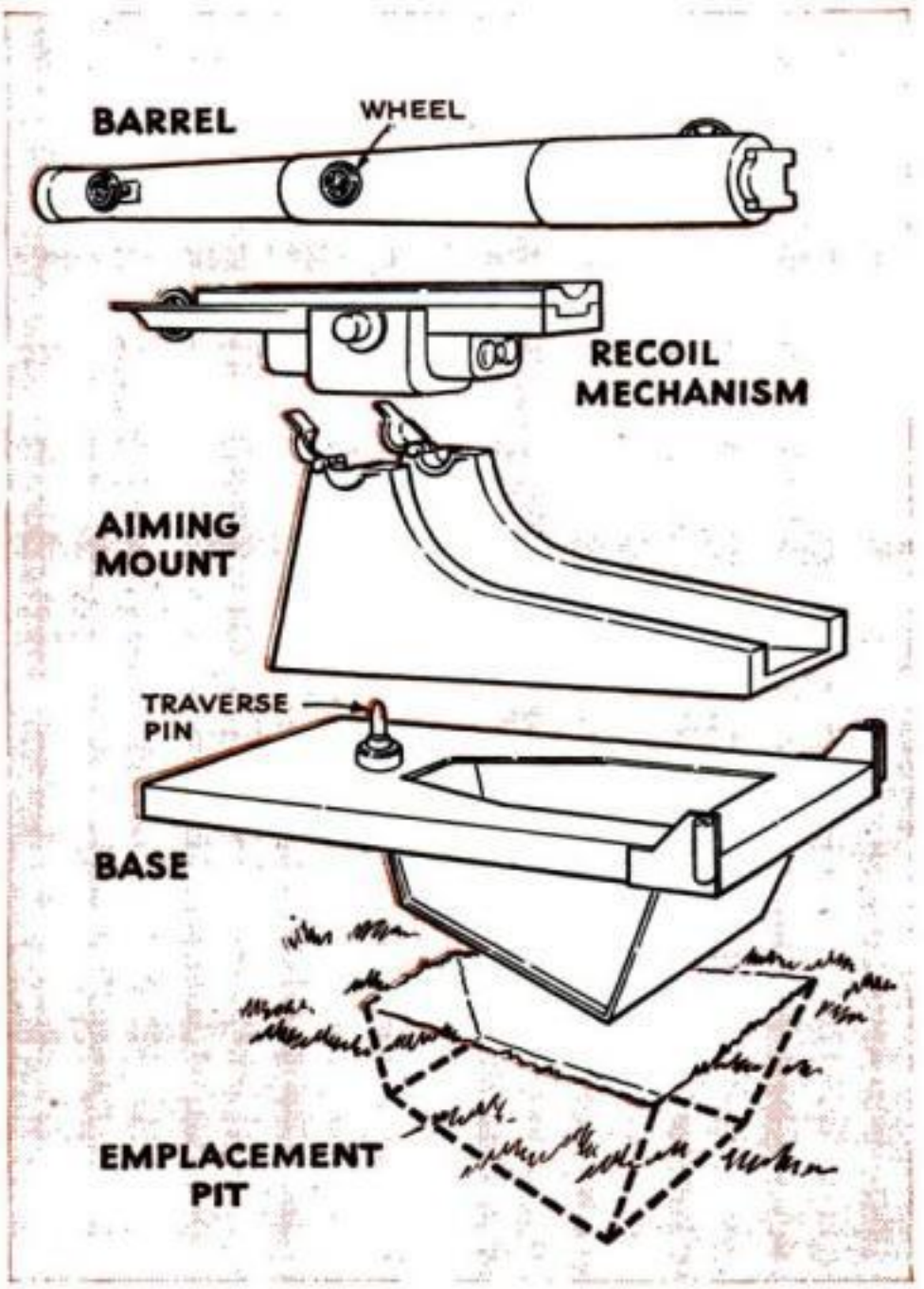
8 ON DECEMBER 17, 1941, SECRETARY OF WAR HENRY L. STIMSON APPOINTED GENERAL EMMONS HEAD OF THE HAWAIIAN DEPARTMENT, GIVING HIM THE MILITARY COMMAND OF THE ISLANDS' AIR FORCE AND LAND FIGHTING UNITS

DYNAMITE ON WHEELS

Ready for action. The big gun throws a 345-pound projectile to an effective range of 14,000 yards

1 Basic aiming is done with a surveyor's transit in laying out the emplacement pit, which is tailored to fit with folding templates shown above

2 Six men dig the 7 by 6 by 3-foot pit in from one to six hours. Three to 12 more hours are needed to set up the gun and organize the position



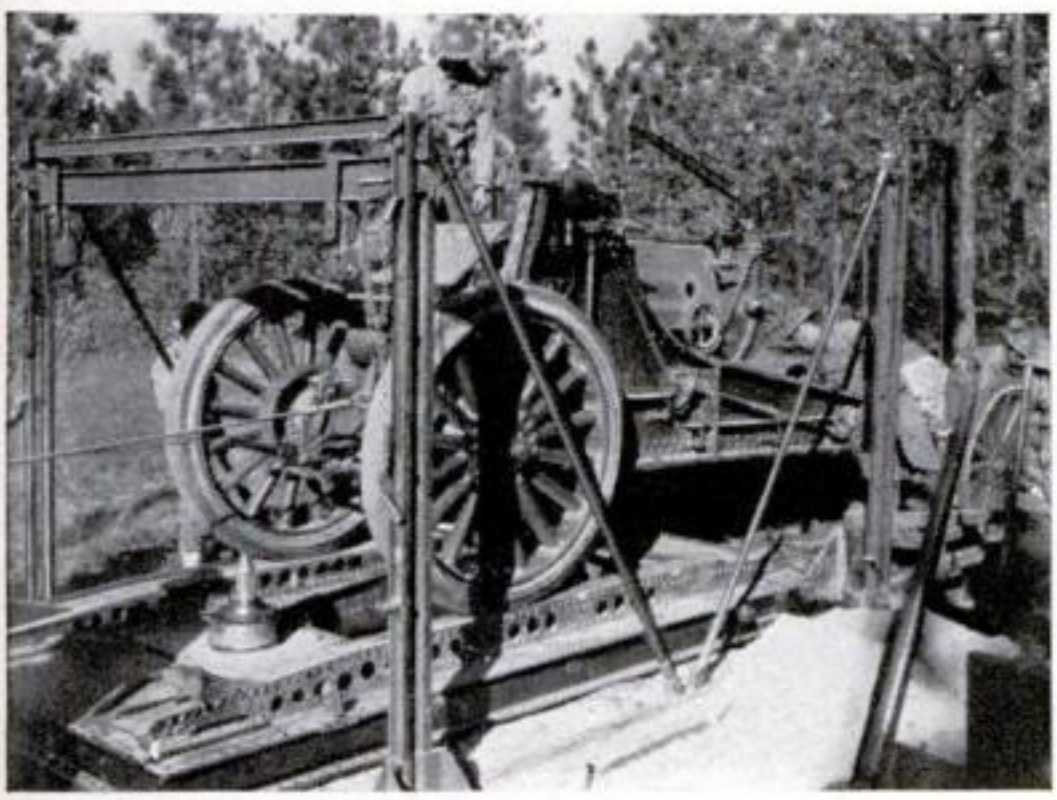
3 Steel ramps laid along the sides of the pit provide solid footing for the wheels supporting the parts of the gun, which are hauled over it

4 A steel erecting frame is set up over the pit. This is used with jacks for lifting the basic parts off their wheels and lowering them in place

The 240-mm. Howitzer Is a Front-Line Assembly Job. Five Heavy Loads Make Up Its 21½ Tons of Destructive Force

5 Installation requires perfect teamwork, since in combat use the gun would be set up overnight in blackout to hammer at some important fixed objective

8 With the erecting frame removed, the recoil mechanism is rolled up on its own trailer wheels and fitted into its place on the mount

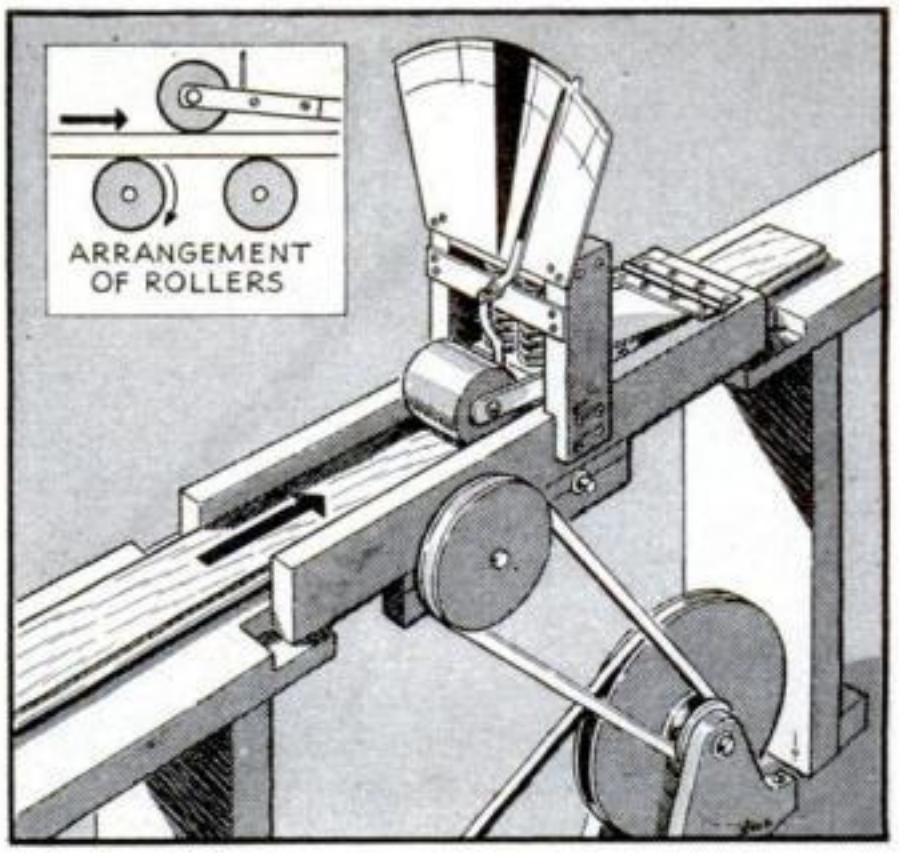


6 Here the base is in position and the aiming mount is being moved into place for lowering over the traverse pin. Trailer loads run as high as eight tons

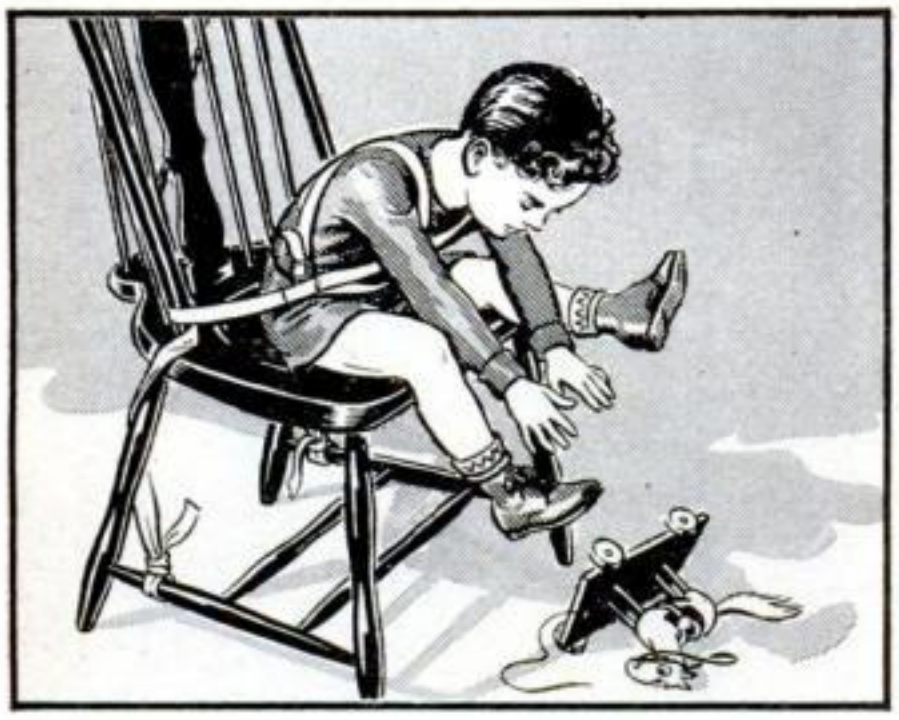
7 As the wheels are unlimbered, they are rolled out of the way. Weighing 1,000 pounds apiece, they support loads that break the average concrete road

9 Hauled by a cable, the 11,010-pound tube rolls into position on its own wheels. At daybreak the assembled gun, camouflaged with chicken wire and canvas, is ready for firing

Improvised Thickness Gauge Sorts Flooring Boards



FLOORING is quickly graded for thickness by the simple, inexpensive wood gauge at the right, devised by a Dickinson, N. D., building contractor. Aimed to eliminate hand grading, this device is made of three hardwood rollers placed on shafts with babbitt bearings. The flooring is pushed over two of the rollers, while the third, which is spring-loaded by two automobile valve springs, rolls on top of the wood. The top roller determines the movement of the dial hand, which in turn indicates the various thicknesses of the flooring. The mechanism is estimated to have saved 100 times its cost in sandpaper and hand labor.

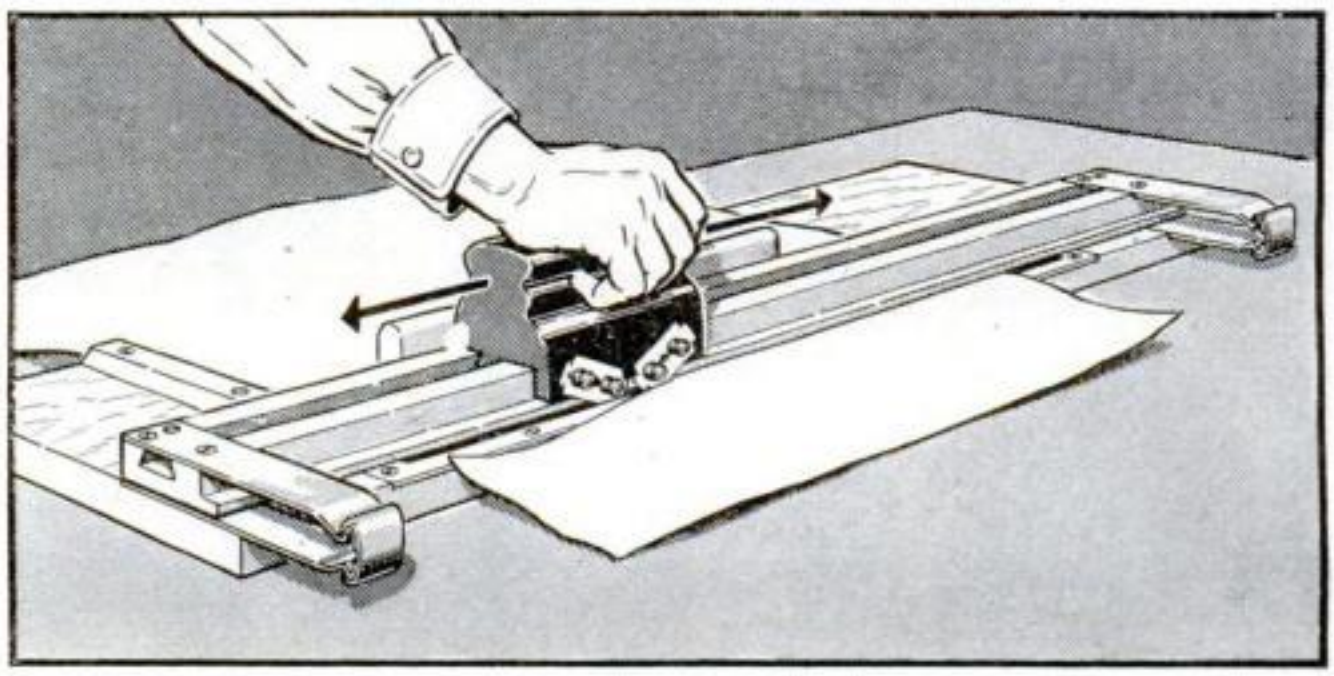


Safety Belt Makes Chair Safe Seat for Child

IF it weren't for the safety belt holding him to the chair, Jimmie, here, would probably take a spill in his efforts to reach that toy horse. Then some one would have to pick him up and put him back. It could go on for hours. But all this can be eliminated by use of a recently patented safety strap which fits over his shoulders and around his waist like a double Sam Browne belt. The ends are securely attached to the chair legs. The strap allows him plenty of movement, yet prevents him from toppling.

Handy Trimming Machine for Offices Uses Old Razor Blades

HERE'S a use for old razor blades. The trimming machine shown below may be maintained at no cost because its cutting edge is made of two used blades attached to a movable block. The block, which is operated by hand, slides on a track which also serves to maintain a firm hold on the material being cut. Designed to replace scissors, rules, and knives in engineering offices and blueprint rooms, where rapid cutting is vital, the device comes in four sizes—32, 38, 50, and 62 inches. It may be moved backward and forward and is said to assure straight and clean edges. Besides being useful in cutting drawings, tracing cloth, and photographic papers, this trimming machine, when used in shops, cuts other materials such as cardboard, skins, and leather.



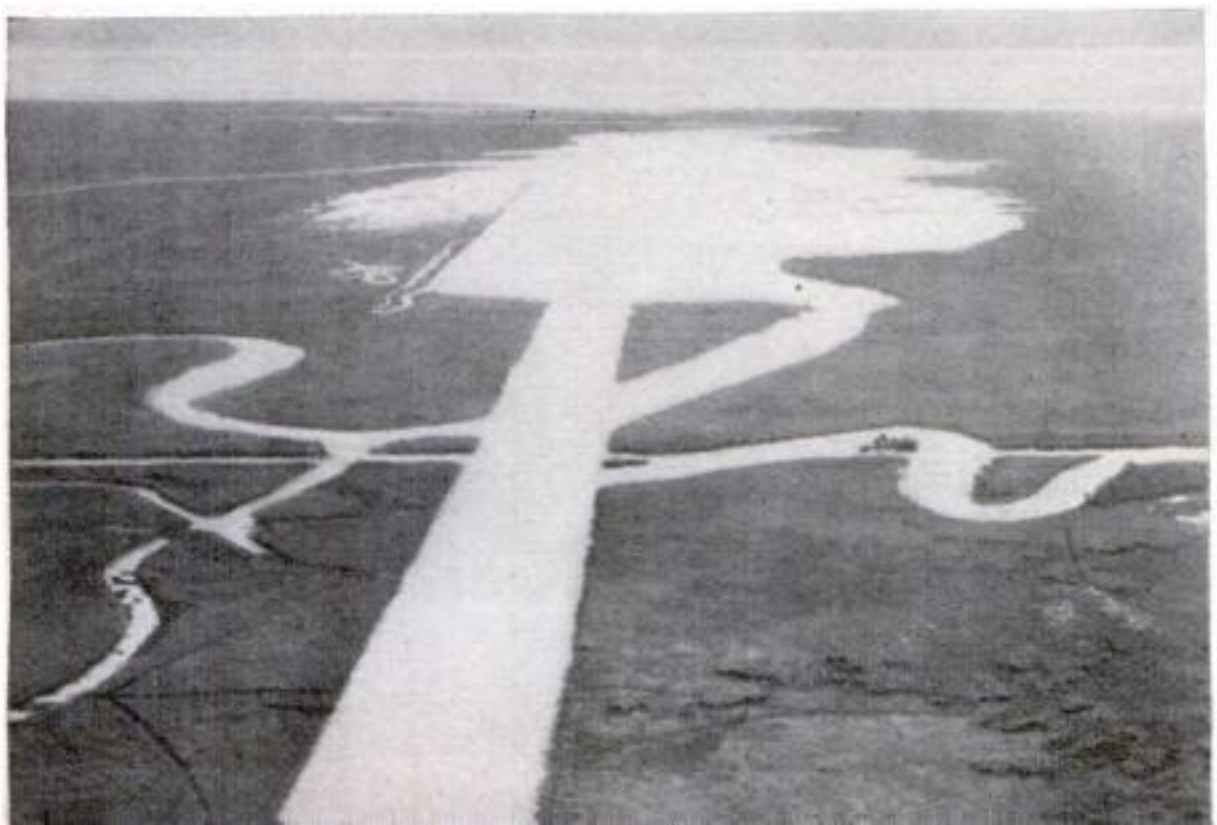
Old Man River Loses His Kinks

ARMY ENGINEERS STRAIGHTEN THE MISSISSIPPI TO SHORTEN BARGE HAULS, REDUCE FLOOD PERIL

THIS year the Mississippi River will flow down its 2,470-mile course, from northern Minnesota to the Gulf of Mexico, under the guidance and direction of the United States Government.

For 14 years the Army's engineers have campaigned to control it, and the final result—a carefully integrated system of locks and dams, levees, revetments, floodways and reservoirs, and cut-offs through 15 of its hairpin bends—not only brings new safety to the residents of the Mississippi Valley but has reduced the river's length almost 120 miles in one 330-mile stretch.

It's not an easy job to change the course of a river. So, to do their job the Mississippi engineers, building on what tools were already available, contrived an ingenious array of machines and implements including a quarter-mile model of the river itself. As the work progressed, new craft mingled with the Mississippi's picturesque stern-wheelers—air-propelled boats to whisk the engineers from place to place, "skitter rigs" for removing snags from the river bottom, vacuum-cleaner dredges, even hydrau-



Straight as an arrow, a cut-off shears a path across a river bend

Published by authority Mississippi River Commission. Aerial photos by U. S. Army Air Corps

Great Lakes

MINNEAPOLIS

LA CROSSE

CHICAGO

River

MOLINE

QUINCY

Missouri River

KANSAS CITY

ALTON

LOUISVILLE

Ohio River

Mississippi

CAIRO

MEMPHIS

Arkansas River

LITTLE ROCK

HELENA

GREENVILLE

VICKSBURG

SHREVEPORT

Red River

NATCHEZ

BATON ROUGE

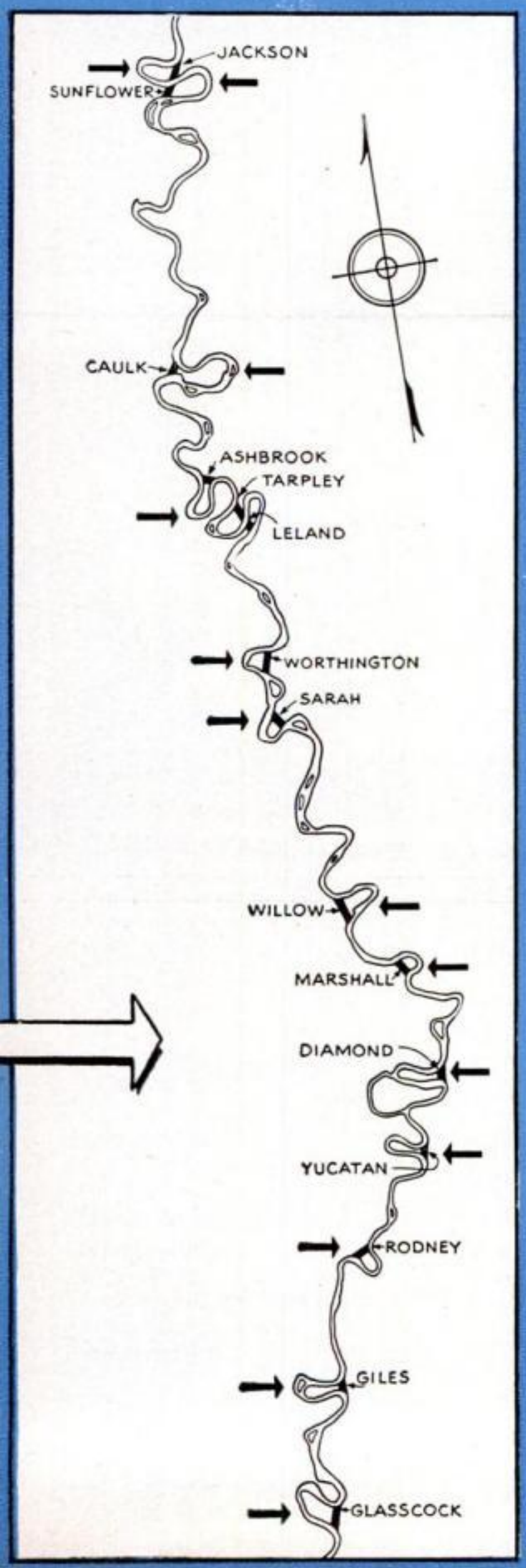
NEW ORLEANS

Gulf of Mexico

In the section of the river covered by the map panel at the right, 14 artificial cut-offs, plus one which Old Man River cut for himself, have shortened the stream by 120 miles, speeded flood run-off

lic mining machinery mounted on barges and used to trim away unwanted river banks.

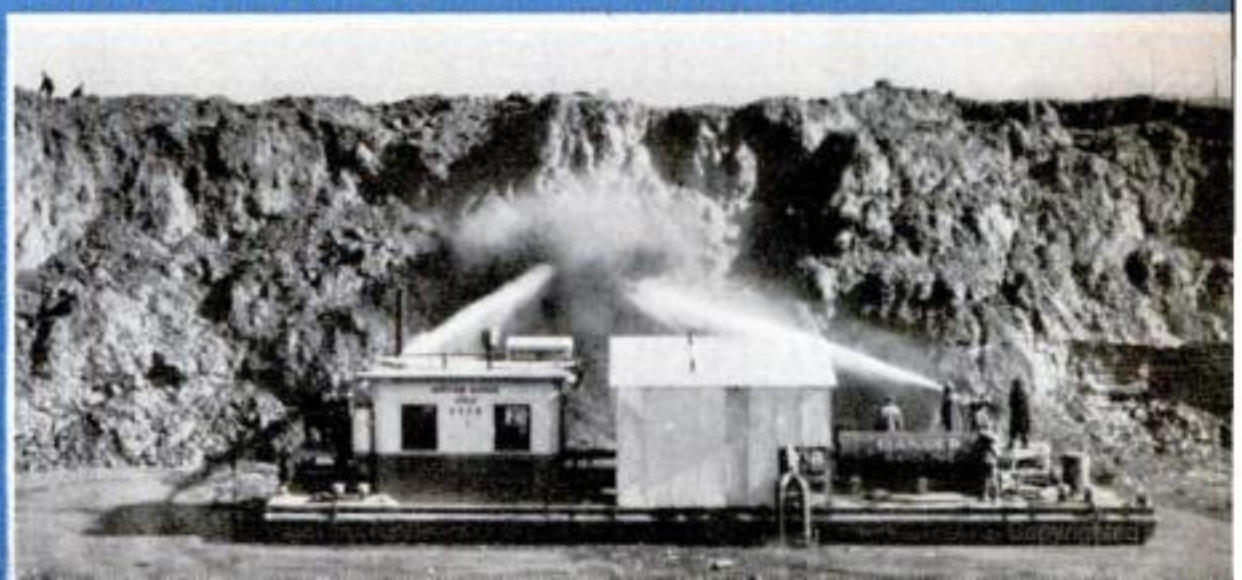
But with all these forces of men and machines the conquest would yet be unfinished had not the strength of the river itself been put to work. At each of the cut-offs, hydraulic dredges started the job by nibbling a pilot cut across the neck of land. Then as the swift current of the river flowed into the trench it scoured the channel to navigable depth and width. Only one tenth of the sand and silt was removed by the dredges, the remainder being carried away by the



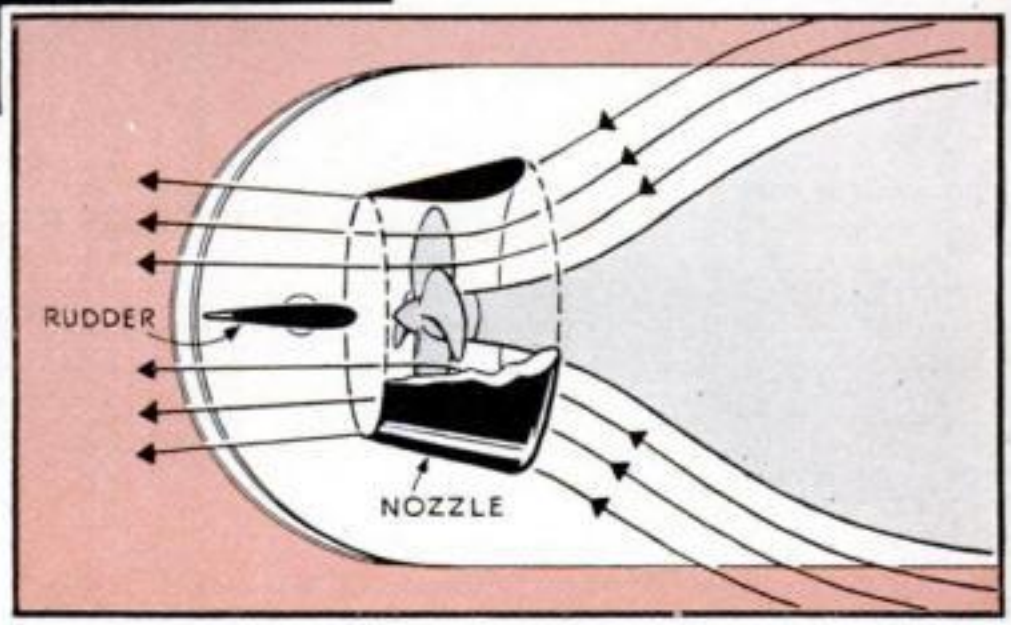
This aerial view, looking downstream, shows pilot cuts being made across Jackson Point and, beyond, across Sunflower Point

Working from both ends, dredges leave a narrow "plug" where they meet. When this is removed, river current scours channel

Below, a hydraulic grader gnaws into the yielding bank. This equipment resembles that formerly used in hydraulic mining



Tunnel-drive towboats, like the model at left, bring the efficiency of screw propulsion to the river barge traffic. A nozzle housing, shown below, protects each propeller from snags and drifting logs, and also gives more thrust. Such boats are replacing the old-time stern-wheelers



irresistible force of the river's own flow.

Dredges of unprecedented size have been built to dig these channels and to keep them open; for the heavier work, large cutterhead dredges capable of chewing up hard clay at a depth of 45 feet and transporting it through more than 6,000 feet of pipe line to the river's banks. Even big waterlogged stumps are included in this monster's diet.

Another type of dredge fitted with a bell-mouthed suction head can drag up its sustenance from a depth of 70 feet, transporting it 2,000 feet by pipe line. Like a seagoing vacuum cleaner, the "dustpan," as it is called, ambles along the river stirring up sandy bottoms with its hydraulic jets and sucking in the disturbed sediment.

Newest of the engineers' tools is the still experimental "subaqueous hydraulic grader," a variation of the hydraulic mining equipment once common in the West. Pumping streams of water under tremendous pressure, it was first used for stabilizing the sloping banks by washing down superfluous dirt. Now, the grader's pressure nozzles are thrust into the river's bed to cut away points of land that threaten to build themselves up into bars.

In making their surveys for the gigantic project, engineers skimmed over the water in air-propelled boats that draw five inches, make 45 miles an hour

Snag boats form the mopping-up squad of the engineering navy and they are perpetually busy, for the Mississippi has been engulfing forests for thousands of years. In two of the new cut-offs dredges unearthed cypress trees which the river had swallowed long before the first white man saw it and in a stratum far below that ancient growth were found the stubs and trunks of a still earlier grove. Recent borings indicate that in the glacial period the bed of the river was 220 feet lower than it is today.

The process of undermining banks and demolishing wooded areas still is going on and the sawyers and niggerheads that slant with the current with their upper ends at or just beneath the surface still constitute a menace to navigation. The snag boats hunt them down. The flagship of the squadron is a big stern-wheeler which is shovel-nosed so it can root under a snag. It is capable of hauling a 90-ton tree up from the bottom of the river, after which the obstruction is sawed into harmless lengths and thrown overside. For ordinary work the "skitter rig" has been found highly efficient. It is extremely economical. Any stout barge with a derrick will do. A light truck is rolled onto the barge, its rear end is jacked up, and one of the rear wheels supplies the power for the hoist. Crews of men demolish the snags with axes or saws as they are hauled in.

Snagging operations, though highly necessary, are a maintenance job rather than

a construction job, an adjunct of navigation rather than of security and it was for security's sake primarily that the Government tackled Old Man River, though the commercial returns will run into high figures. The cut-offs, the strengthened levee system, the overflow reservoirs, and the other devices for restraining the flood fury of the river are all for safety's sake, though already the advantage to commerce is obvious.

The work on the levees, however, has a direct bearing on the security phase of the enterprise and its magnitude is hardly less astonishing than that of the cut-offs. Seven hundred million cubic yards of fill have been used in strengthening the levee system over a 2,000-mile stretch. That is more than twice the amount of material that was removed in constructing the Panama Canal.

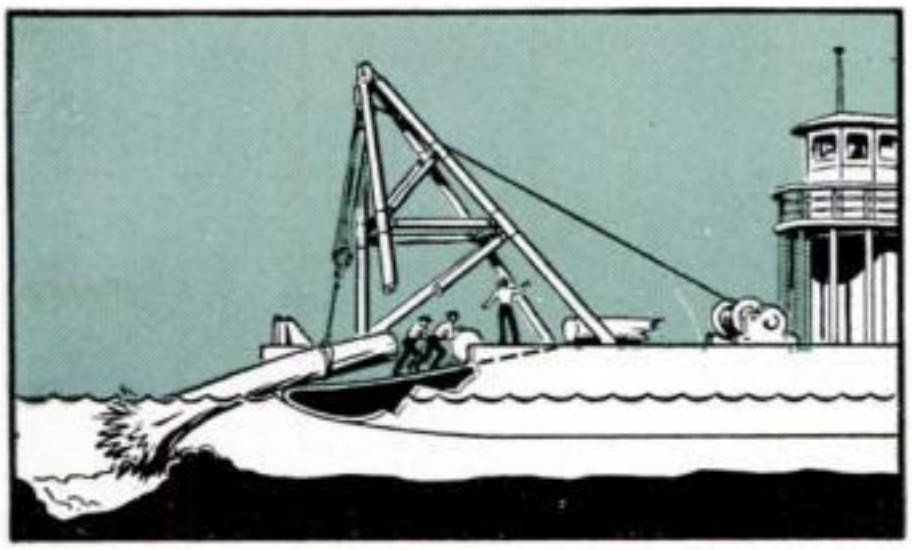
The material used was analyzed for durability and permeability, and similar studies were made of the sites where it was used. No potential weakness that science could ferret out was overlooked. The effect of the new cut-offs was studied carefully. One effect of shortening the channel of the lower river is that a flood crest reaches the Gulf of Mexico two days quicker than it used to. It was found that at Vicksburg, where the river running bank-full used to carry down 1,000,000 cubic feet of water each second, it now carries 1,500,000 cubic feet a second and the flood stage has been lowered by eight feet.

The acceleration meant a greater strain at some places, too. Sometimes the cut-off channel and the channel above it were widened to reduce the strength of the current, and sometimes banks threatened with erosion were strengthened with revetments. This used to be done with bunches of willow branches, and such bank facings still are used in some places. There were other places, however, where the river just chewed them up with casual swiftness and in such spots the engineers are spreading aprons of linked concrete blocks or reinforced asphalt.

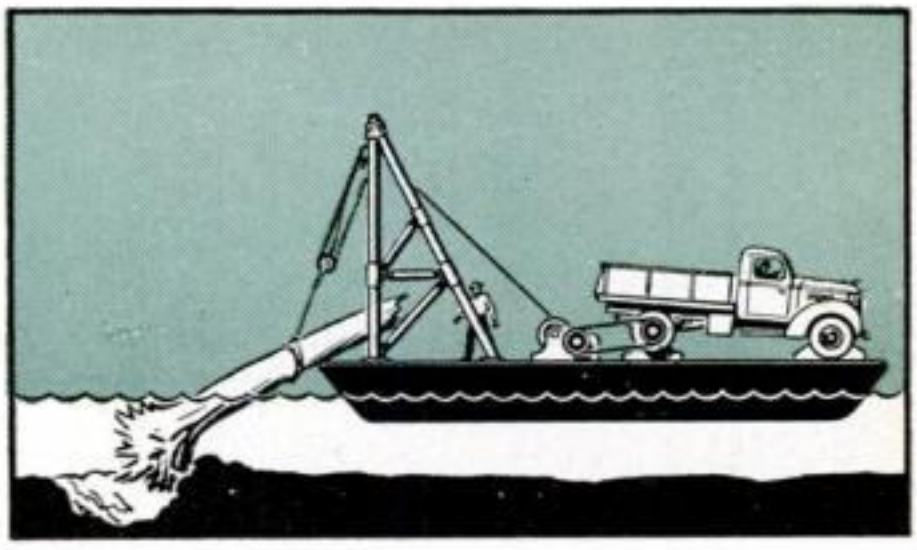
The mats of concrete blocks are made in units 25 feet long and four feet wide,

Snagging is a part of channel improvement. Here the steamer C. B. Reese, with special equipment mounted on her bow, is removing trees that have washed off the bank and are embedded in the bottom

Snag boat with shovel-nosed bows roots trunks from the bottom and hoists them aboard for cutting up



More economical is the skitter rig, a barge with a light truck aboard to furnish power for the hoist



and are formed in a floating casting plant, a concrete-mixing barge moving along a string of from eight to 16 casting barges on whose decks the forms are laid. Reinforcing wires somewhat resembling a length of sheep fence run through slots in the forms into which the concrete is poured.

These mats of concrete slabs, looped together with wire so that the whole area is massively flexible, are laid by being slid from the tilted superdeck of a specially constructed "sinking" barge. The first layer is put down close to shore and is securely anchored there. Then the barge moves out a little and sinks another length of the concrete apron. With the aid of a double train of rollers on its tilted deck sections of the concrete mattress 25 feet wide and from 100 to 140 feet in length are laid in one operation.

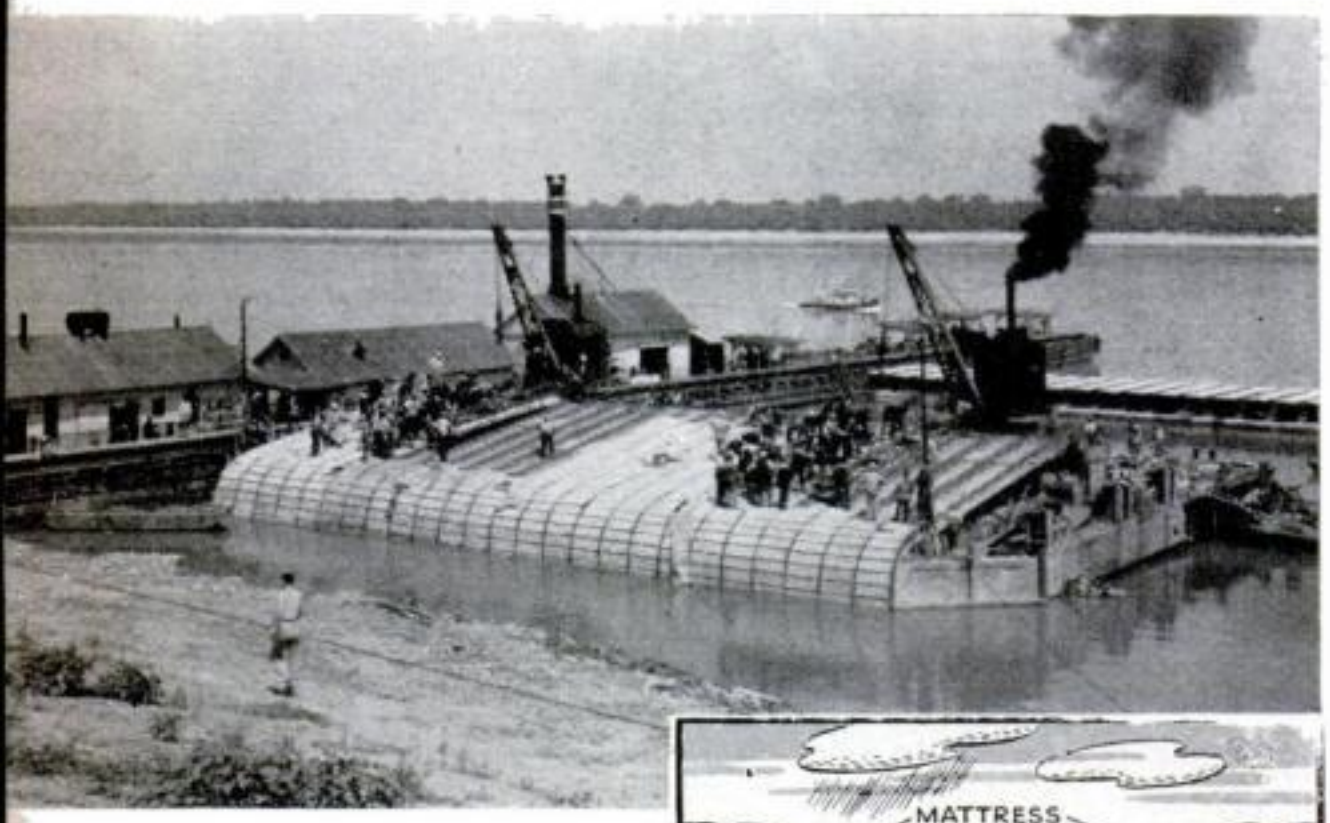
The mats of reinforced asphalt were first used in 1935. A floating paving machine manufactures the asphalt apron, which goes oversides from rollers on a tilted deck just as the concrete revetment does. In the 14-year campaign which began in 1928, 500,000 linear feet of revetment have been laid.

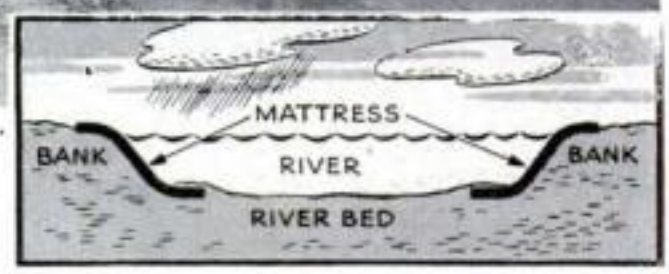
At strategic points gaps have been left in the levees to provide floodways that act as safety valves when the river is in flood. The Wappapello dam and reservoir stand guard at the St. Francis River in Missouri. A backwater levee at the mouth of the White River in Arkansas provides an emergency reservoir for the protection of main-line levees in flood times. The Sardis dam and reservoir and the Arkabutla dam and reservoir protect the Yazoo Delta. The new cut-offs, all between Helena, Ark., and the Red River, increase the capacity of the main channel for carrying off flood water. As a result of the Ashbrook cut-off, opposite Arkansas City, the bend just below it is showing a marked tendency to straighten itself for the accommodation of the water which now is delivered in increased volume.

The Leland cut-off, lopping off the looping Bachelor Bend, has put Greenville on the horseshoe-shaped lake which formerly was the bend and, while leaving it open for commerce, has greatly reduced the flood peril which was of annual recurrence when the waters from above began piling up in the bend.

The region around the Atchafayala Basin in Louisiana, another spot where the Mississippi was wont to romp maliciously, has been protected by a floodway on the west side of the basin embracing a tract seven miles wide and 43 miles long. This floodway is to be utilized only in time of excessively high water threatening the newly strengthened

(Continued on page 223)





RIVER-BANK MATTRESS
To prevent erosion at danger points, mattresses of concrete or asphalt are laid over the bank. Above, a barge is ready to lay a mattress of articulated concrete slabs. Below, sinking an asphalt mattress. As the barge is moved back from under the completed section, paving machines aboard the craft start laying the next section on the metal backing

Craftsmen Volunteer for War Production

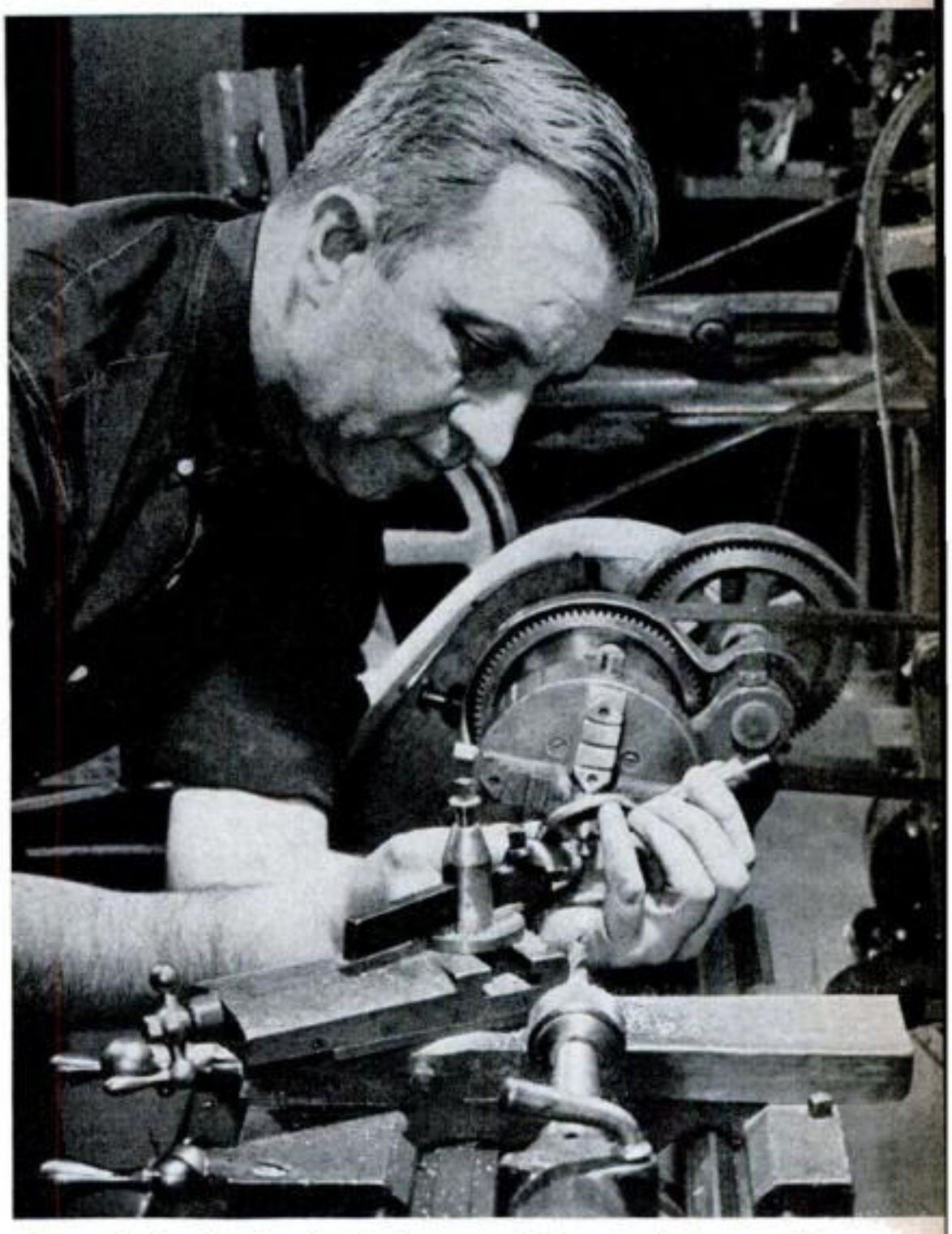
WHAT YOU CAN DO FOR DEFENSE

A NATION-WIDE SURVEY BEING MADE BY POPULAR SCIENCE REVEALS THAT MANY WELL-EQUIPPED HOME WORKSHOPS AND OTHER SMALL SHOPS ARE AVAILABLE FOR PRODUCING "BITS AND PIECES." THE FOLLOWING ARTICLE TELLS HOW IT IS PLANNED TO USE THIS INFORMATION. IF YOU WISH TO REGISTER, FILL OUT THE FORM BEGINNING ON PAGE 75

By ARTHUR GRAHAME

SKILLED craftsmen, patriotically eager to take their places on the industrial firing line in the all-important battle of production that America must win *now,* are registering for war-production work by the thousands in the survey of home-workshop manpower, skills, and machine-tool equipment being made by POPULAR SCIENCE MONTHLY.

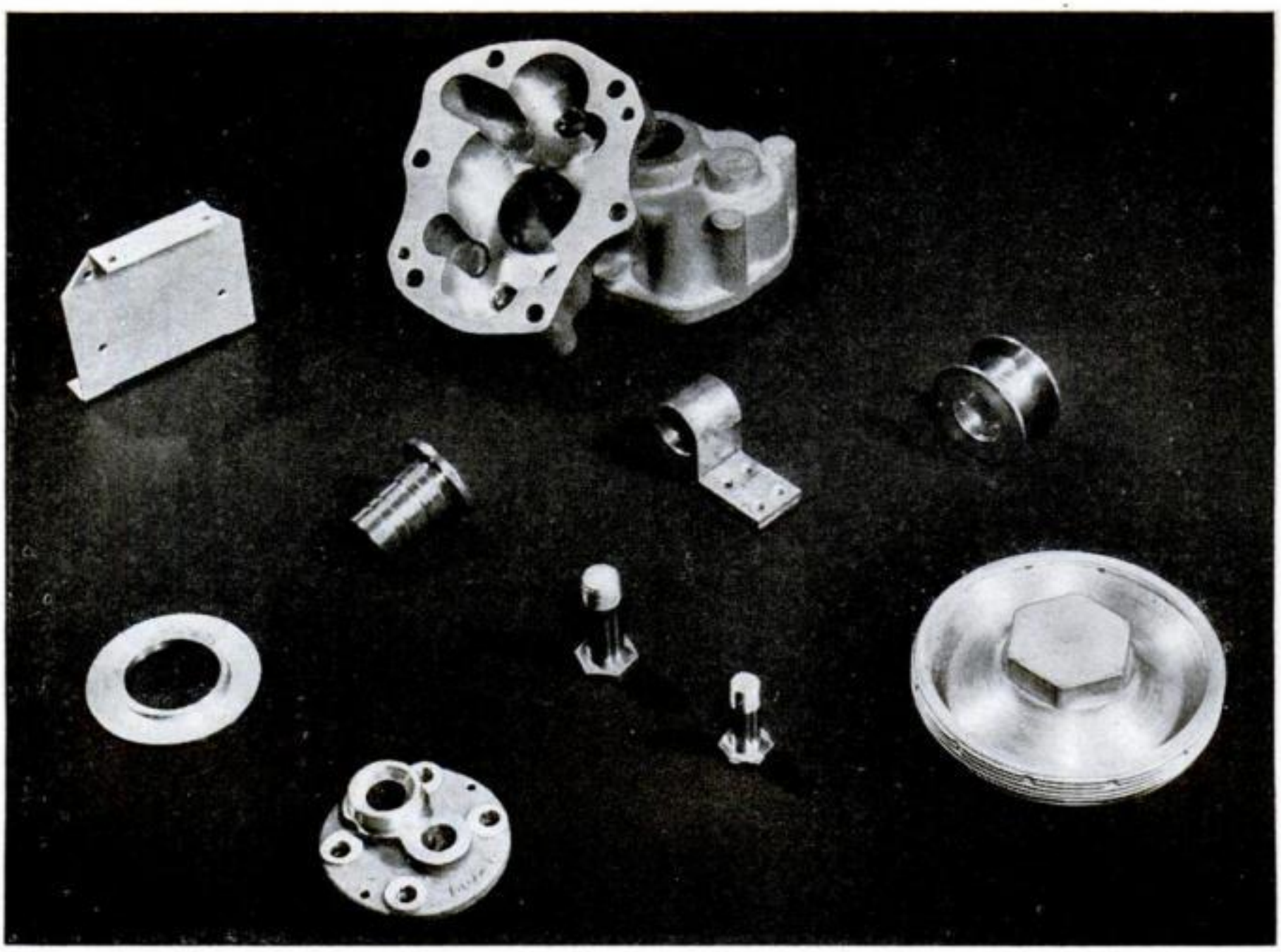
This survey was undertaken with the sole purpose of assisting the Government in its complex task of mobilizing big and little American industries to make the weapons and munitions with which the fighting forces of the democracies will win the sweeping air, land, and sea victories which will smash Hitler and his Japanese accomplices. Registration forms are coming from all parts of the country. As soon as they are received they are being rushed to the Contract Distribution Branch of the War Production Board — successor of OPM — in Washington. There they are studied and analyzed by expert production engineers. I have been permitted to follow some of the forms through the engineers' office and can assure those who have registered that the information they have supplied is being handled with the same care and attention to detail as is given data concerning large-scale manufacturing facilities obtained through WPB's own surveys.



One of the hundreds of home-workshop enthusiasts who have registered to make their skill available for defense

Just how the information obtained through the home-workshop survey will be used is, of course, a question for WPB decision. Tentative plans call for its being tabulated by states and districts and sent to the WPB field offices concerned, and there made available to all holders of contracts who want to subcontract part of their work. WPB has sent all its field offices reprints of the article in our March issue which told of the outstanding success of Stanley A. Carlson in increasing the war production of his plant by using hobbyists and other home-workshop craftsmen as subcontractors. Acting as chief industrial consultant in the Contract Distribution Branch, Mr. Carlson is developing methods of using his system in many parts of the country.

Craftsmen who have volunteered for war-production work naturally are anxious to obtain subcontracts and get busy on them, but the chances are that nearly all of them



"Bits and pieces"—war-materials parts selected by engineers of the Contract Distribution Branch of the War Production Board as suitable for production in the average well-equipped small shop. They are part of a display maintained at field offices along with staffs of experts to advise persons doing work

will have to display some of the patience which is demanded of every citizen in wartime. Mobilizing the widely scattered industrial facilities of America is a good deal like trying to put together a gigantic jigsaw puzzle of victory. In our all-out industrial mobilization the great manufacturing plants which have been or are being converted to 100-percent war production are the big pieces of the puzzle; the small plants, the alley machine shops, and the home workshops are the little pieces. In spite of the desperate need for speed and for every machine tool that can be put to work, the big pieces have to be put in place first, and then the just-as-important little pieces have to be fitted into the nooks and crannies to complete the picture.

If you have sent in your registration form, you have expressed your willingness to serve and have told the Government what you can contribute to this mighty national effort. Having done that, you should wait until you are called on for your services. By visiting, telephoning, or even writing your local WPB field office you will slow down the work of organization. Above all, don't yield to the universal American impulse to go to Washington to try to speed things up. The War Production Board's Washington headquarters is concerned solely with national-scale planning, and it isn't staffed to handle the details of subcontracting.

Written while registration forms are flooding in with every mail, this article cannot attempt to give anything like a detailed picture of the over-all results of the home-workshop survey. But examination of some of the first forms which were received disclosed several trends that are both important and interesting. Some of them are:

Home-workshop craftsmen own a surprisingly large number of efficient machine tools. The first 500 forms that came in listed a total of 484 lathes, 357 drill presses, 182 grinders, 53 screw machines, and a large number of woodworking tools. This heavy ownership of power-driven equipment is especially impressive to WPB engineers, who see in it a certain indication of a highly important and hitherto unknown or neglected reservoir of machine tools and men skilled in operating them.

Ownership of machine tools by home-workshop hobbyists is heaviest in industrial areas, but it also is widespread. The first 100 forms received *(Continued on page 76)*

U. S. Wants ALL Home-Workshop Owners to Register for War Production

IT is urgently necessary to find out at once what contribution the home workshops of the United States can make in the production of war materials.

To obtain this information with the least possible delay, POPULAR SCIENCE MONTHLY is making a survey to be placed at the disposal of the War Production Board in Washington. The individual forms, after being numbered and recorded, are sent to Washington for study and redistribution to the field offices of the Contract Distribution Branch of the Production Division, WPB.

The purpose of the registration is to provide a comprehensive survey of immediately available home-workshop facilities—manpower, skills, and equipment. What we are asking you to do now—and all we are asking you to do—is to say that you will devote your skill, your shop equipment, and your spare time or full time to this work if and when the Government asks you to do so.

It should be made clear that this work is not to be contributed without pay. Usually it is done for contractors, not directly for the Government. Because of this, home-workshop operators are freed of all red tape involved in so-called "direct procurement." They are supplied with materials, so they do not have the difficulty of obtaining their own. They are also given various production aids and bookkeeping assistance.

Please bear in mind that even the task of surveying available home workshops is a gigantic one. Because the task is so immense and because every one concerned is straining to increase production as quickly as possible, we ask that those readers who fill out the form do not become impatient. Above all, DO NOT WRITE, PHONE, OR VISIT the district offices to inquire about registrations. It will simply impede matters and cause confusion and delay.

The thing for you to do—and do now—is to register. To win the war, men and machines must be mobilized in one great, all-out effort. Do your part by filling out the survey form today.

WAR-WORK REGISTRATION FORM FOR HOME CRAFTSMEN

Note: DO NOT fill out this form if you have previously registered. Instead, call it to the attention of some friend or neighbor who might be interested in registering. If you wish to avoid cutting these pages, you may obtain a duplicate of this form by sending a self-addressed, stamped envelope to Popular Science Monthly.

N 4

NAME.....

(Please print or typewrite)

STREET ADDRESS.....

CITY OR TOWN.....

COUNTY..... STATE.....

Age..... Occupation..... Position held.....

Are you regularly employed, employed part time, unemployed, or a student?.....

Check the schools from which you have been graduated.

☐ Grade school ☐ High school ☐ Vocational school

☐ Correspondence school (..... course)

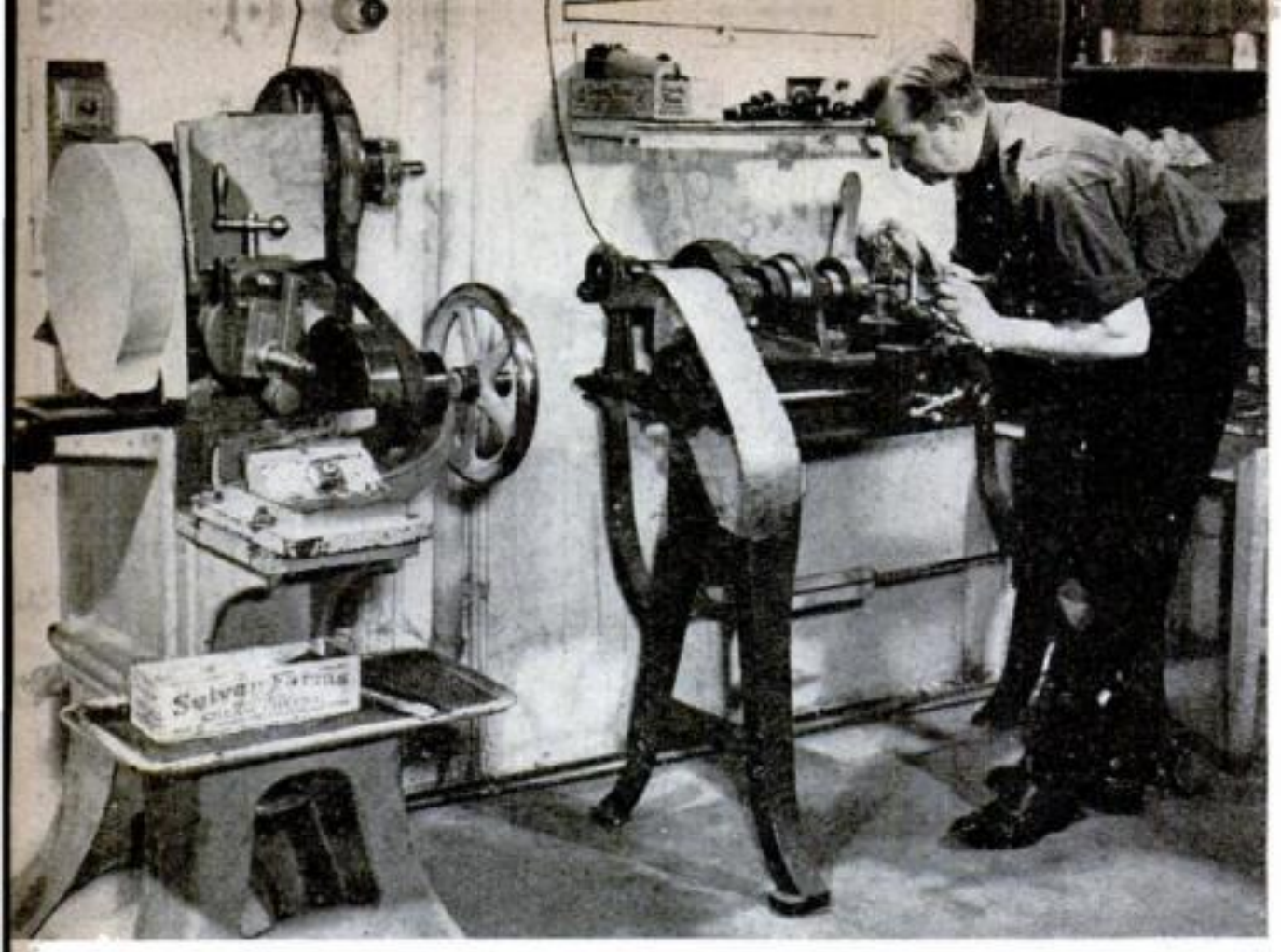
☐ College (major subject, ...)

What mechanical experience have you had?.....

.....

.....

FORM CONTINUES ON NEXT PAGE ⟶



Part of the shop of the hobbyist shown on page 73. The machine at the left is a 40-year-old metal shaper, still capable of doing good work

came from 29 states, and every state of the Union was represented in the first 500.

A large proportion of the men who are registering are holders of full-time jobs. Of the first 100 forms received, 73 were from men who are employed full time, 10 were from men who are employed part time, and 7 were from men who are retired or unemployed. Those who are employed full time offered to devote an average of 32 hours a week to war-production work.

About one third of those registering feel that they are capable of giving instruction in machine-shop practice to others, and are willing to use their own equipment for that purpose. If they obtain subcontracts, these men probably will be able to step up their production by training unskilled workers.

A fair proportion of the registrants are capable of doing high-precision machine-tool work. Some are accustomed to working to a minimum tolerance of .0005", and a few to a minimum tolerance of .0001".

One of the first registration forms received came from a mechanical engineer who holds degrees from Syracuse and Yale, and who edits a technical magazine which is the standard publication in its field. Back in his college years he devoted his summer vacations to gaining practical experience

Check which of these machines (or equipment) you can operate, and add any not listed.

	Grade		Grade
☐ Metal-turning lathe	.....	☐ Metal shaper	.....
☐ Drill press	.....	☐ Screw machine	.....
☐ Milling machine	.....	☐ Boring machine	.....
☐ Welding (arc, spot, torch)	.....	☐ Heat-treating	.....
☐ Grinding (surface, etc.)	.....	☐	.....
☐	.....	☐	.....

Note: After each machine or type of equipment you have checked, please add one of the following letters to indicate the degree of skill you possess: E for expert or foreman grade. J for journeyman or average grade. S for semi-skilled or apprentice grade. B for beginner.

Can you read simple blueprints?.....

What mechanical projects, articles, or parts have you constructed, either for pay or as a hobby?

.....

.....

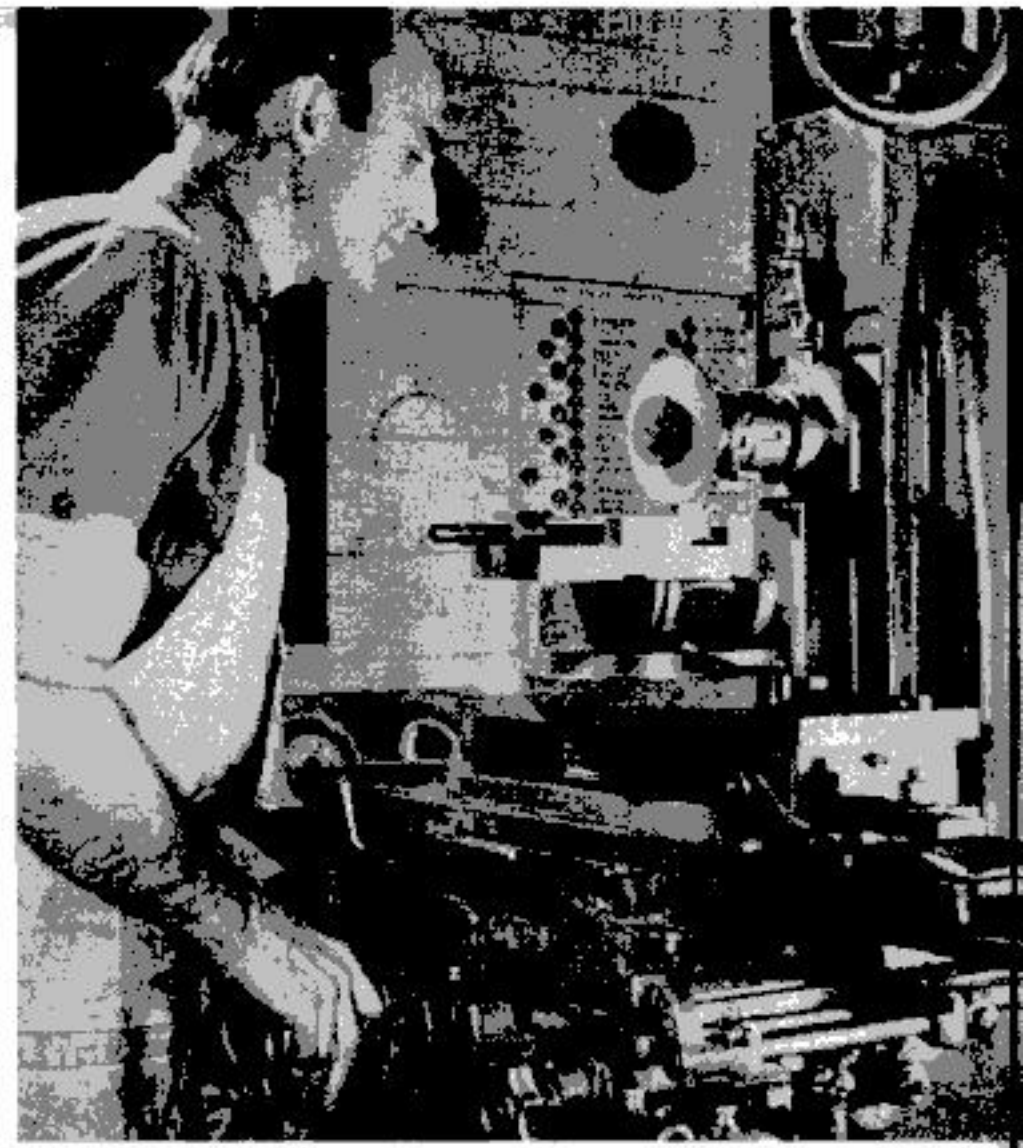
If you operate a metal-turning lathe or other machine-shop tool, what is the minimum tolerance to which you are accustomed to work?.....

FORM CONTINUES ON NEXT PAGE ⟶

by working as a machinist. Metal working always has been his favorite hobby, and he has a well-equipped machine shop in his Long Island home. He served as an artillery lieutenant in the last war, and is anxious to do his bit in this one by working 20 hours a week on any war-production job that his machines can handle. Highly skilled in the making of interpretive models used for visualizing power-plant design, he feels that he could be most useful in the making of special experimental tools, fixtures, or instruments.

Another early-bird registration form came from a Pennsylvania minister. Before he entered the ministry he had gained practical mechanical experience by working for several manufacturers. Model railroading is his favorite hobby, and in the course of 14 years of it he has built six locomotives. He also has taught model-airplane building in a vocational school, and has conducted a radio program on model building. He has a drill press and other tools, and could devote between 35 and 45 hours a week to war work. On his registration form he wrote: "Good for you, POPULAR SCIENCE. I saw the need for this survey over a year ago, and predicted that it would be made."

One reader, 75 years old, whose home is on Long Island, New York, wants to use the fruits of his 50 years' experience as a machinist, tool maker, shop foreman, designing engineer, and factory superintendent to help win the war. He has a completely equipped home workshop.



This man, a Swiss watchmaker, is using his skill in precision work in turning out tungsten-carbide tools

Other early registrants included a New

LIST THE MACHINES IN YOUR SHOP AVAILABLE FOR PRODUCTIVE WORK

MACHINE	SIZE, TYPE, AND MAKE	CONDITION

In case you are called upon to make parts or do special work for a Government contractor or subcontractor, how many hours a week could you devote to this activity, provided the materials were supplied and you were paid at a reasonable rate?.....

FORM CONTINUES ON NEXT PAGE ⟶

York advertising copywriter, a Montana physician, an Ohio bee raiser, a Florida salesman, a Nebraska billiard-room manager, a Colorado newspaper editor, an Illinois banker, a Pennsylvania thermometer worker, an Arizona rancher, a Georgia factory manager, a Nevada mining engineer, a New Jersey inventor, a North Dakota postman, a Massachusetts experimental engineer, a California printer, and a Minnesota apartment-house owner and operator.

Home-workshop clubs in several cities have asked for registration forms for all their members. Among them are the Home Craft Club of Pittsburgh, the Oklahoma City Home Workshop Club, and the Nashville Homeworkshop Club.

An architect of Spokane, Wash., airmailed a request for 100 forms, saying that the manager of his local Contract Distribution Branch field office had asked him to act as chairman of a committee appointed to obtain the registration of all home-workshop craftsmen in the Spokane district.

One mechanic employed in the vibration laboratory of an airplane-propeller manufacturer asked for forms for several of his fellow workers, saying: "After reading your article 'Home Workshops Go To War,' it occurred to us that there would be a chance for us to help by using our spare time and the skill that we have acquired in making various electronic equipment."

President Roosevelt has called for the production of 60,000 airplanes this year and 125,000 next year, of 45,000 tanks this year and 75,000 next year, of 20,000 antiaircraft guns this year and 35,000 next year, and of 8 million tons of shipping this year and 10 million tons in 1943—and those are just the more spectacular items of the most stupendous production job that any nation ever had to tackle.

That job has to be done, and it has to be done in a hurry. To do it we are going to need every serviceable machine tool, new or old, that we can lay our hands on, and every man, professional machinist or amateur, who knows how to operate a machine tool.

Home-workshop craftsmen can't build ships or airplanes in their back yards, or tanks or antiaircraft guns in their basement machine shops. But they *can* make many of the thousands of small parts that go into the building of ships, planes, tanks, and guns. The survey made by POPULAR SCIENCE is showing that they have the necessary tools. The thousands of registration forms which are coming in prove that they have the desire to turn their leisure into many hundreds of thousands of now priceless man-hours of skilled labor.

Are you able to give instruction in machine-shop practice to others?..... How many hours a week could you teach?..... Could your own machines and equipment be used for such instruction?.....

If you are familiar with any part or assembly of war matériel which you would be especially interested in making, please describe it as completely as possible.....

.....

.....

.....

List the names and addresses of other mechanically minded men who might be interested in enrolling for this type of work so that registration forms may be mailed to them.

.....

.....

.....

.....

IT IS URGENT THAT THIS SURVEY BE COMPLETED AS QUICKLY AS POSSIBLE. PLEASE FILL OUT THE FORM IMMEDIATELY IF YOU ARE ABLE TO HELP PRODUCTION IN ANY OF THE WAYS MENTIONED. ADDRESS WAR-WORK REGISTRATION, POPULAR SCIENCE MONTHLY, 353 FOURTH AVENUE, NEW YORK, AND MAIL AT ONCE.

HOME CRAFTSMEN INVITED TO MAKE

Model Planes for the Navy

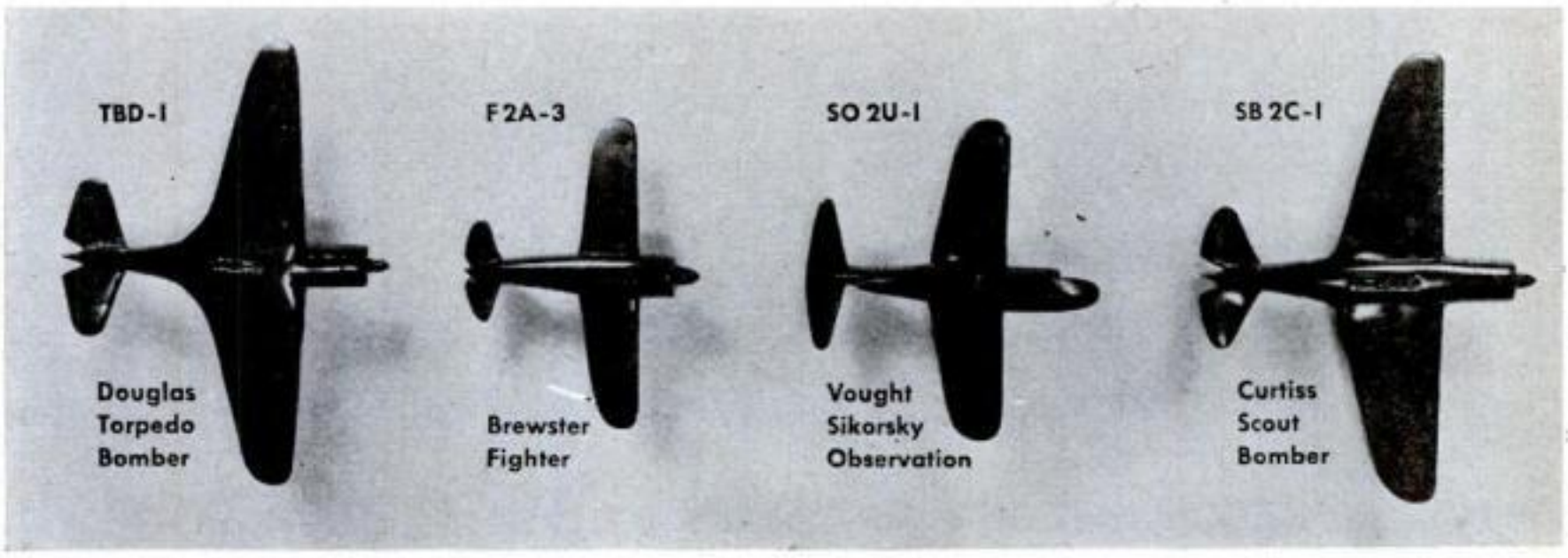
Model of Vought Sikorsky OS2U-1 for use by Navy personnel and civilian spotters. Right, modeling the Brewster "Buffalo," another of the 50 planes in the series

THE United States Navy has invited home craftsmen to help immediately with a project requiring skill and speed. It is an urgent request to turn out at least 500,000 model airplanes as quickly as possible. They are needed to train Army, Navy, and civilian personnel in aircraft recognition and range estimation in gunnery practice.

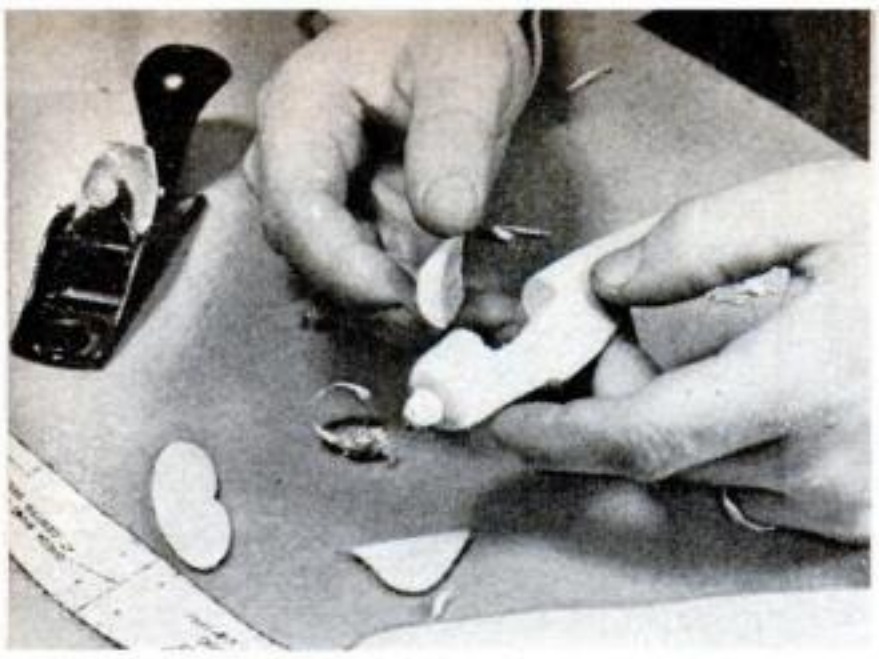
If you own or operate a home workshop, or have access to simple woodworking tools, your skill can be put to work immediately in this task.

The first step is to find out from your local Superintendent of Schools who has been authorized to distribute the working plans of the models. If the local superintendent does not know, write or telephone the County or State superintendent. The same official who distributes the working drawings will also inform you regarding quotas of models expected from your district, and will tell you where to procure

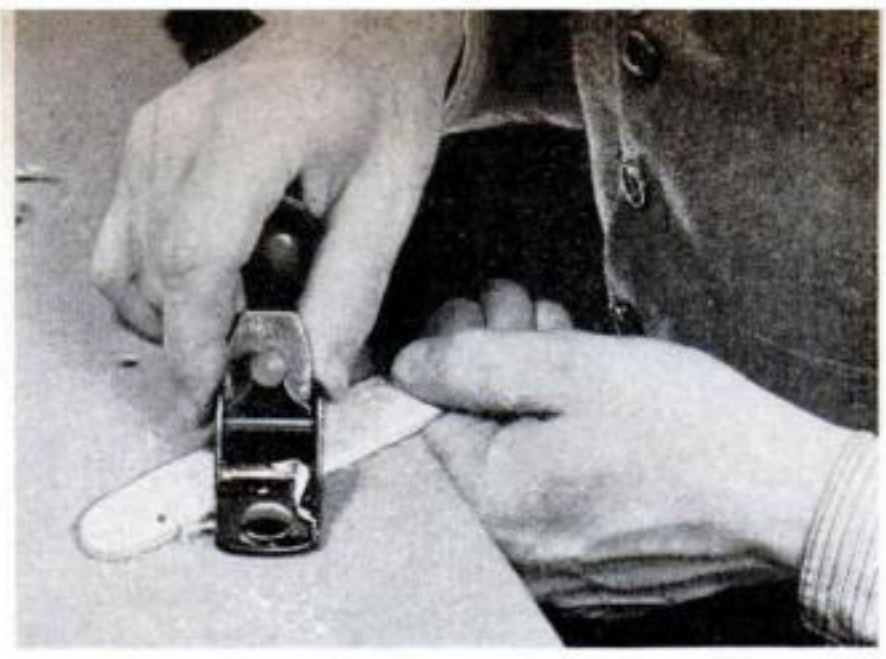
WHAT YOU CAN DO FOR DEFENSE



Painted black, models made by home craftsmen help teach Navy men to recognize planes, estimate range



Assembling the Brewster "Buffalo" model. Plans are being distributed by school superintendents to workshop fans volunteering for this urgent project



Smoothing a wing with a thumb plane. While special model makers' tools are helpful, they are not essential in constructing these simple scale models

materials. He will also be responsible for accepting for shipment to Washington your completed models.

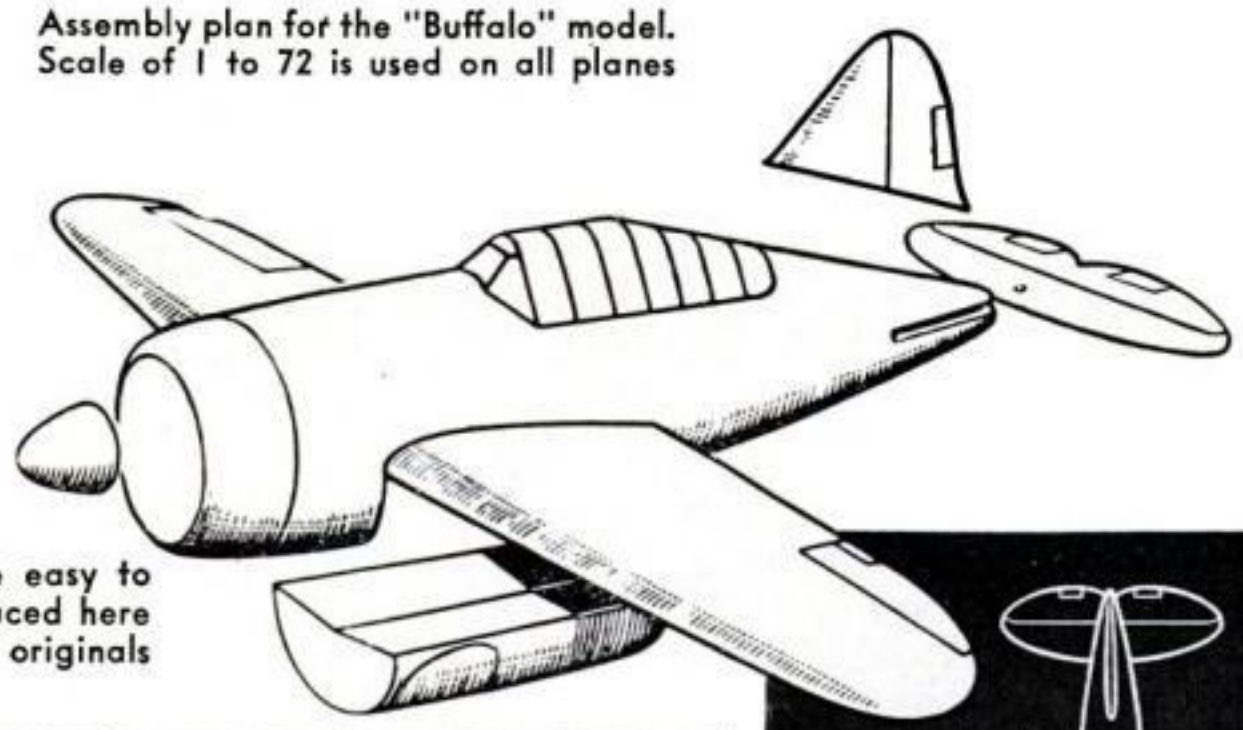
The first sets of working drawings—plans for 50 American and Axis planes to a set—will be distributed through local school officials by March 1, 1942. They will come from the U. S. Office of Education. The models will be held to a precise scale of one inch to 72 inches. They will be rigidly inspected before use. Soft woods such as poplar and white pine will be used. Balsa wood will not be accepted.

The perfection of detail in the models, and the precise ratio of one to 72 upon which they are constructed, will enable cadets and civilian spotters to learn identification more quickly than is possible by any other method. Gunnery students, for example, will study the models at a distance of 35 feet, and know that the model seen will correspond to a real airplane seen at just under half a mile, for estimation of range.

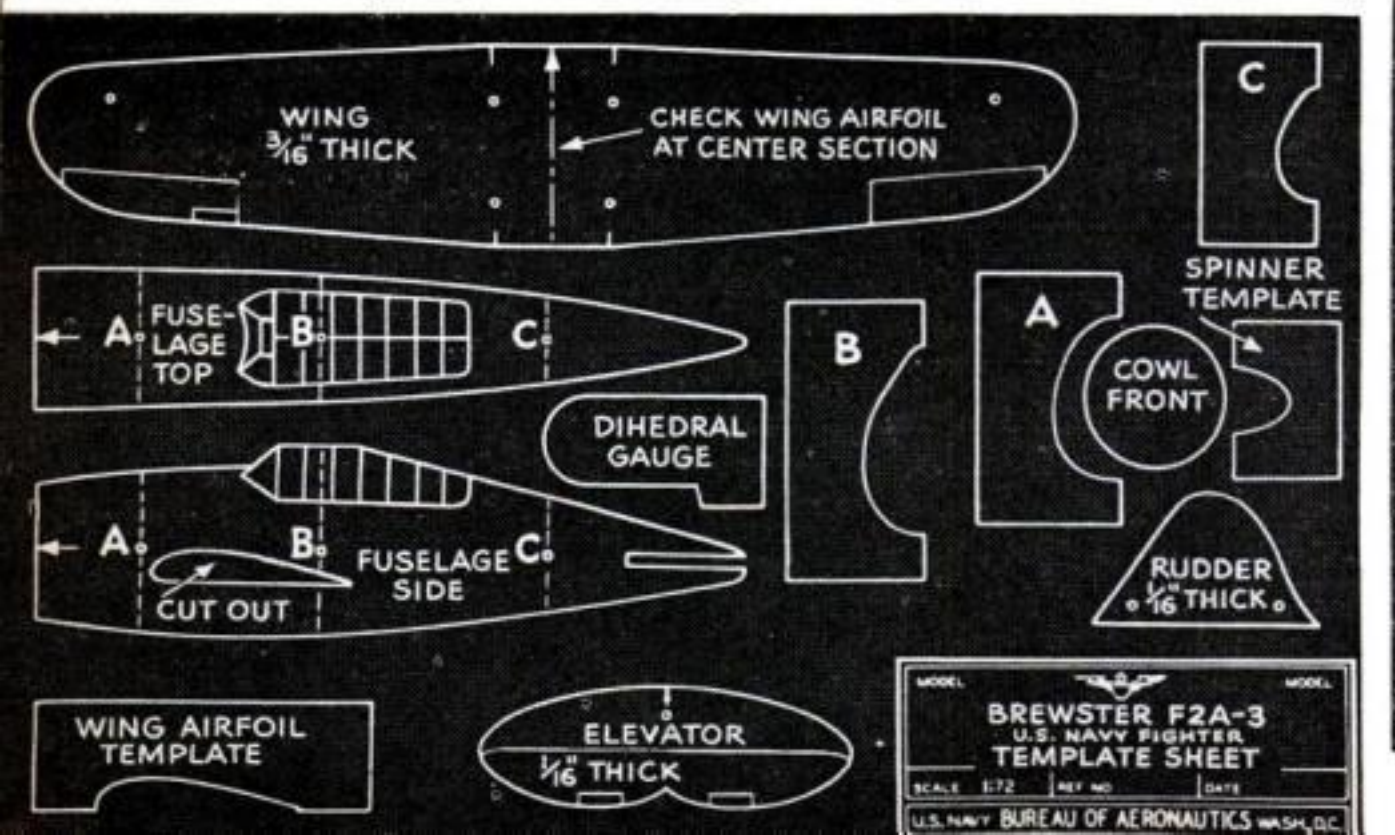
The smallest models will have a wing spread of 5½ inches; the largest 25 inches. Most wing spreads will be less than 12 inches. They will be packed at local expense in sets of 50, one plane of each type, but the Government will pay shipping costs. The half million models so urgently needed now are only a start, and officials expect that production will be continued long after the original quota has been filled.

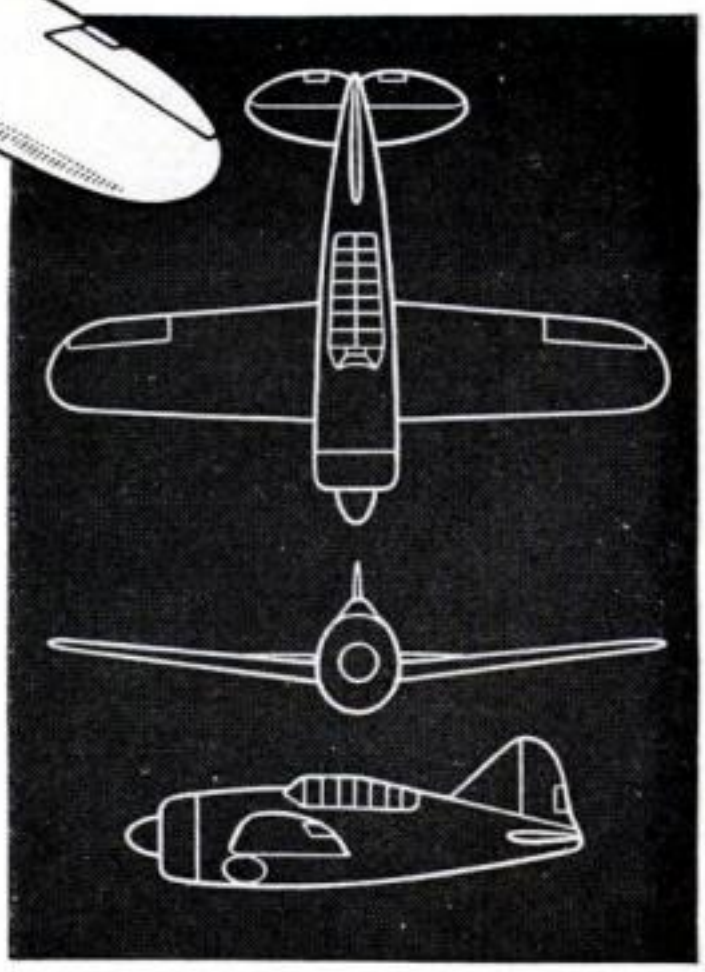
Home craftsmen who complete a given number of sets will be given certificates in recognition of their work. This job should provide an answer to many who, since Pearl Harbor, have asked "What can I do?"

Assembly plan for the "Buffalo" model. Scale of 1 to 72 is used on all planes



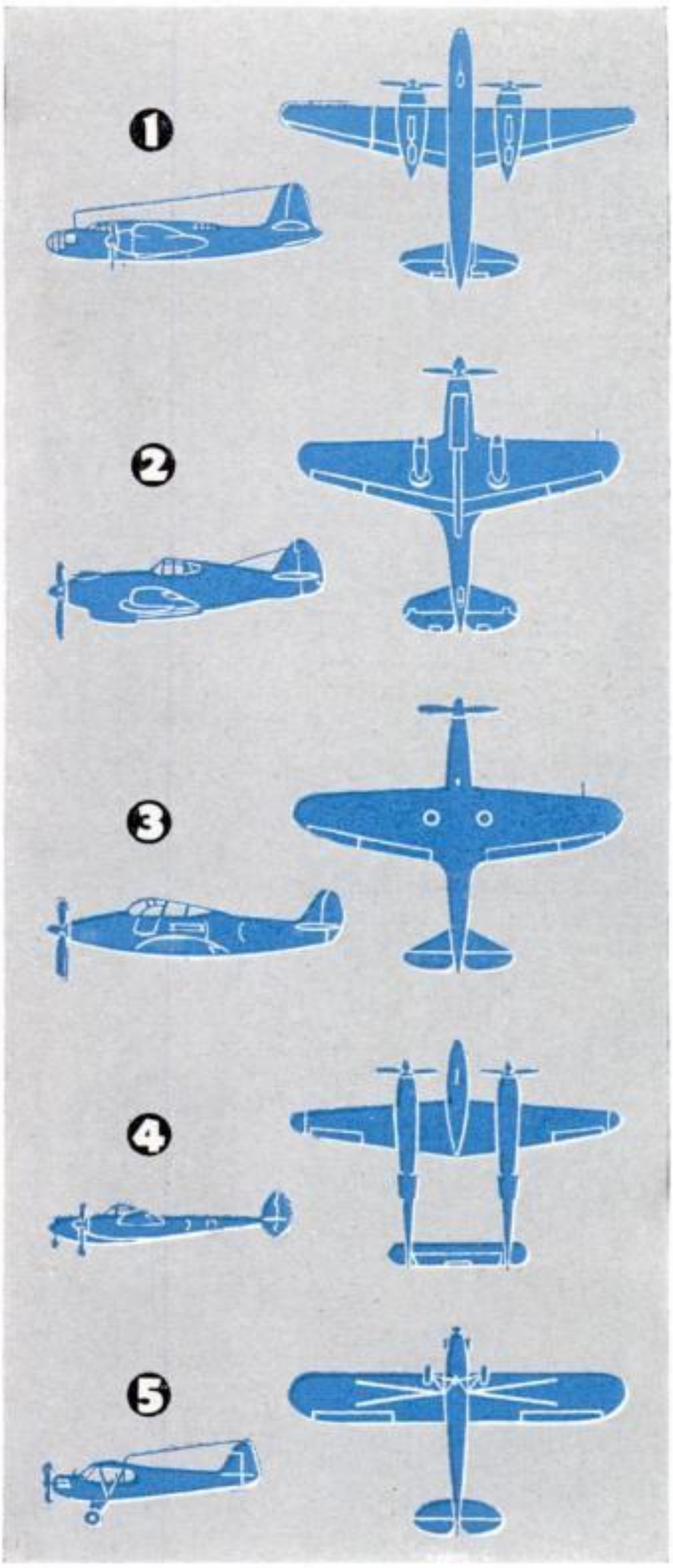
Template plans like this are easy to use. The drawings as reproduced here are one-half the size of the originals

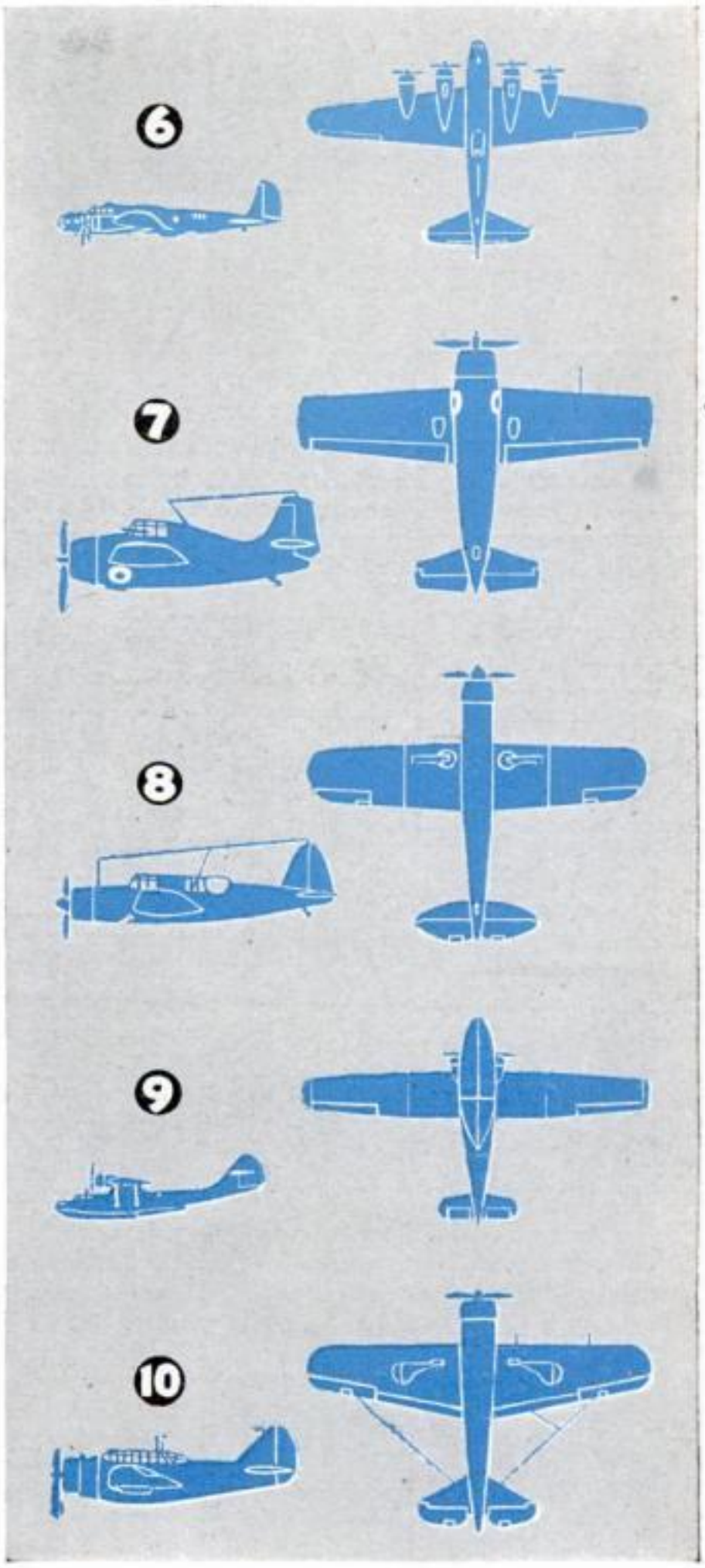




Question Bee

CAN YOU IDENTIFY THESE TEN WARPLANES? You have seen photographs of these planes frequently in POPULAR SCIENCE and other magazines. You have seen some of them in the air. Can you recognize them? They include the P-38 Pursuit, O-47 Observation, Piper Cub "Grasshopper," Brewster Dive Bomber, Grumman Fighter, B-17 Flying Fortress, PBY Patrol Bomber, P-40 Pursuit, A-20A Attack Bomber, and P-39 Pursuit. But which is which? Try to identify them, then check your results with the correct answers given upside down below





1 A-20A Attack Bomber
2 P-40 Pursuit
3 P-39 Pursuit
4 P-38 Pursuit
5 Piper Cub "Grasshopper"
6 B-17 Flying Fortress
7 Grumman Fighter (F4F-3)
8 Brewster Dive Bomber (SB2A-1)
9 PBY Patrol Bomber
10 O-47 Observation

FM RADIO JOINS THE ARMY

Staticless System Used in Tanks and Scouting Units to Beat Interference, Enemy Jamming

By ROGER BURLINGAME

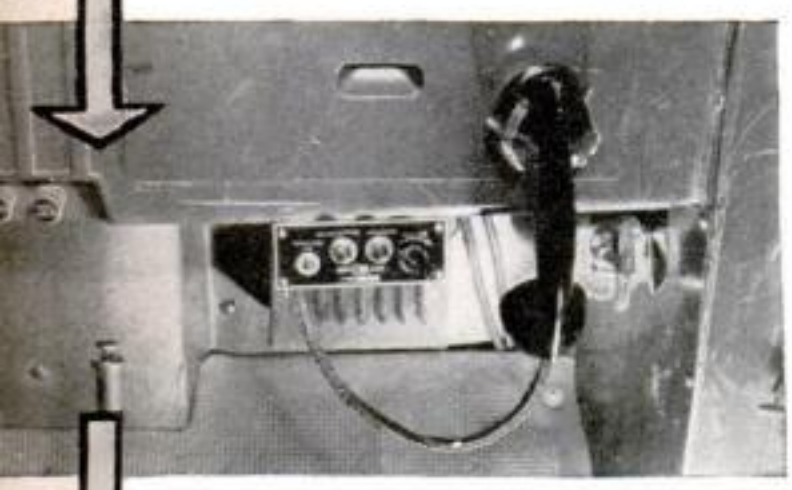
JUST in time for America's supreme war effort comes a new system which jumps many of the hurdles in radio communication for military and emergency defense work. It is called FM, in commercial broadcasting already famous as a static eliminator.

A few years ago, communication with a mechanized army in the field had to be either two-way communication by the old telegraphic code signals requiring trained operators, or one-way communication by voice. Radiotelephony broadcast to mobile units such as command cars, trucks, reconnaissance patrols, tanks, etc., required a powerful transmitter to overcome noise and interference. Such a transmitter was too large, heavy, and cumbersome to be installed in a mobile unit to provide talking back. For tanks which, in themselves, set up violent disturbances, even one-way voice communication was unreliable.

Today, the operator of a tank, speaking in an ordinary tone, can talk quietly with other tanks or with command cars. He can receive orders from command posts or send back news of his position or of the action in which he is engaged. Only the voice is used. The tank operator's voice is not communicated through an ordinary microphone but through two disks pressed against his throat. He hears through headphones built into his helmet. Thus his hands are left entirely free. Tuning is done automatically by the use of push buttons and requires no skill.

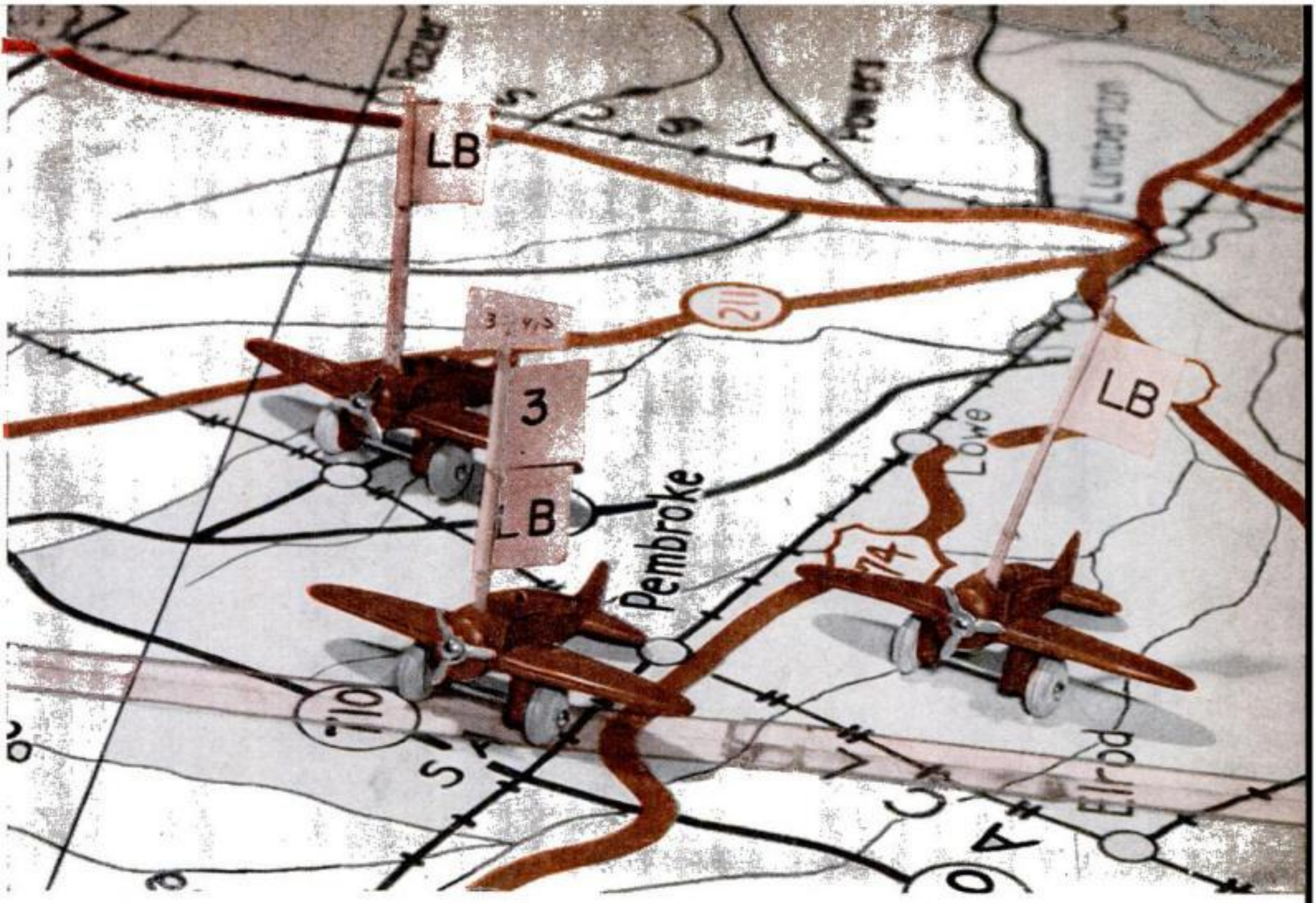
Ordinary communication from a tank is short-range—about one mile. Power can, however, be increased by the operator if necessary either to increase the range or to blank out another signal—a new FM tech-

An Army reconnaissance unit (in this case a command car) equipped with FM radio. From some hidden point of vantage, the observer notes enemy activity and immediately reports it . . .



. using simple push-button controls mounted on the dash. The transmitter and receiver may be located in the rear of the car, as below, or in any other handy place

The message goes first to a mobile relay station within range, from which it can be passed on to headquarters or a warning may be sent directly to combat units. Comparatively short range of FM prevents interception or jamming of messages by the enemy



On a map at headquarters, model airplanes and tanks represent hostile units. (Here LB means light bomber)

These men are plotting enemy movements reported by reconnaissance units. This is the map shown above

Headquarters station also is carried on a truck. High spots are chosen to increase the range of transmission

nique which will be described later.

A tank platoon has been put through rapid and complex operations entirely by radio with no visual signals. This simple two-way system has made possible a novel method of reconnaissance called the Combat Zone Warning Service, especially useful in anti-tank maneuvers. CZWS has, in effect, mechanized the old scouts which used to move out on all sides of an army unit to give warning

In the combat units, a simple transceiver (combined receiver and transmitter) like this is used for two-way communication with the headquarters station

of the enemy's approach or other doings.

At headquarters is a 250-watt FM transmitter mounted on a truck. From it orders are sent out through relay stations to small reconnaissance units. These have receivers to pick up messages, and transmitters by which they can talk back. Reconnaissance units are small vehicles such as "jeeps" which may be concealed in woods, bushes, or other cover. Any of them which detects enemy activity can send a message to the relay station which may either relay it back to headquarters or directly warn a combat unit.

All this has become possible through FM —or rather through the particular frequency-modulation system invented and perfected by Major Edwin H. Armstrong. As everyone who has followed radio development knows, this system was invented primarily to do away with static and man-made disturbances which produce noise in the receiver. In the words of Major Armstrong, this is done by transmitting "a wave which is different in character from the static" and by using a "receiver which responds only to this new type of wave and is deaf to the 'amplitude modulations' of the noise currents and substantially deaf also to the small frequency swings occurring in the noise by using a wide frequency band." Actually, this "different" wave is a wave of constant amplitude whose frequency is widely varied by the sound pattern imposed upon it—an exact reversal of previous accepted practice. FM is further insured against noise by operating in the ultra-high frequencies. The informed general public has come, in the last few years, to understand this.

But what the public is only beginning to learn is the immense advantage gained from other incidental effects of FM which adapt it so beautifully to military and police use. Apart from noise reduction, these are, briefly: low-power operation, low-cost operation, short-range transmission, easy adjustment of range, compactness of units, facility of operation by unskilled operators, complete absence of distortion or "squeal" caused by the interference between signals, and the opening up of a multitude of new communication channels. Most of these effects are, of course, derived from the basic properties of FM which make possible the elimination of static and noise.

With the amplitude-modulation system, called AM, the high power necessary to overcome both noise and interference increases operation cost and size of apparatus. Furthermore, interfering signals on the same frequency are difficult to drown out.

FM does not drown out an interfering signal, it "blanks" it out. Only one signal can come through at a time in an FM receiver. The familiar jumble of sounds coming from two stations using the same frequency—which everyone has heard in his AM set—is impossible with FM. The more powerful signal always come through, clear and undistorted, even if its amplitude is only a little greater. So the operator of an FM transmitter can blank out other signals at will by only slightly increasing his power. Actually a ratio of 2 to 1 will blank out a weaker signal on the same frequency whereas a ratio of 20 to 1 is necessary in AM to overcome such interference.

At the same time, this blanking out cannot be done successfully at great distances, for FM is essentially a short-range system. Commercial broadcasting over distances greater than 50 miles requires high antennas on high ground. Therefore the enemy, even if he possesses FM field equipment, cannot blank out or "jam" signals unless he is very near.

The Army learned of FM from the police. About a year ago, a number of Signal Corps officers and engineers from Fort Monmouth were invited to Hartford, Conn., to see a demonstration by the pioneer police users of

the Armstrong system—the Connecticut State Police. The story of what they saw will explain, better than any theoretical description, why the Army has gone in for FM.

Connecticut, an area of 4,965 square miles, is divided into ten barracks areas. The barracks are not in the centers of the areas they represent, and there are no high antenna poles rising from them. Yet in each barrack, a dispatcher sits at a desk talking by radio with police cars and with other barracks.

The dispatcher is handling the transmitter by remote two-wire control, because a barrack and a transmitter require two different sets of conditions. A barrack must be on a main highway, easily accessible to motorists and handy for sending out cars in a hurry. An FM transmitter using ultra-high frequencies should be on the highest ground available and should be in the center of the area to which it transmits. So the 200-foot steel masts carrying the antennas are put on hilltops, often in the middle of woods or fields. In a welded-steel shack below each mast is housed the transmitter and receiving equipment. From this shack—called the "station"—wires run to the area's barrack.

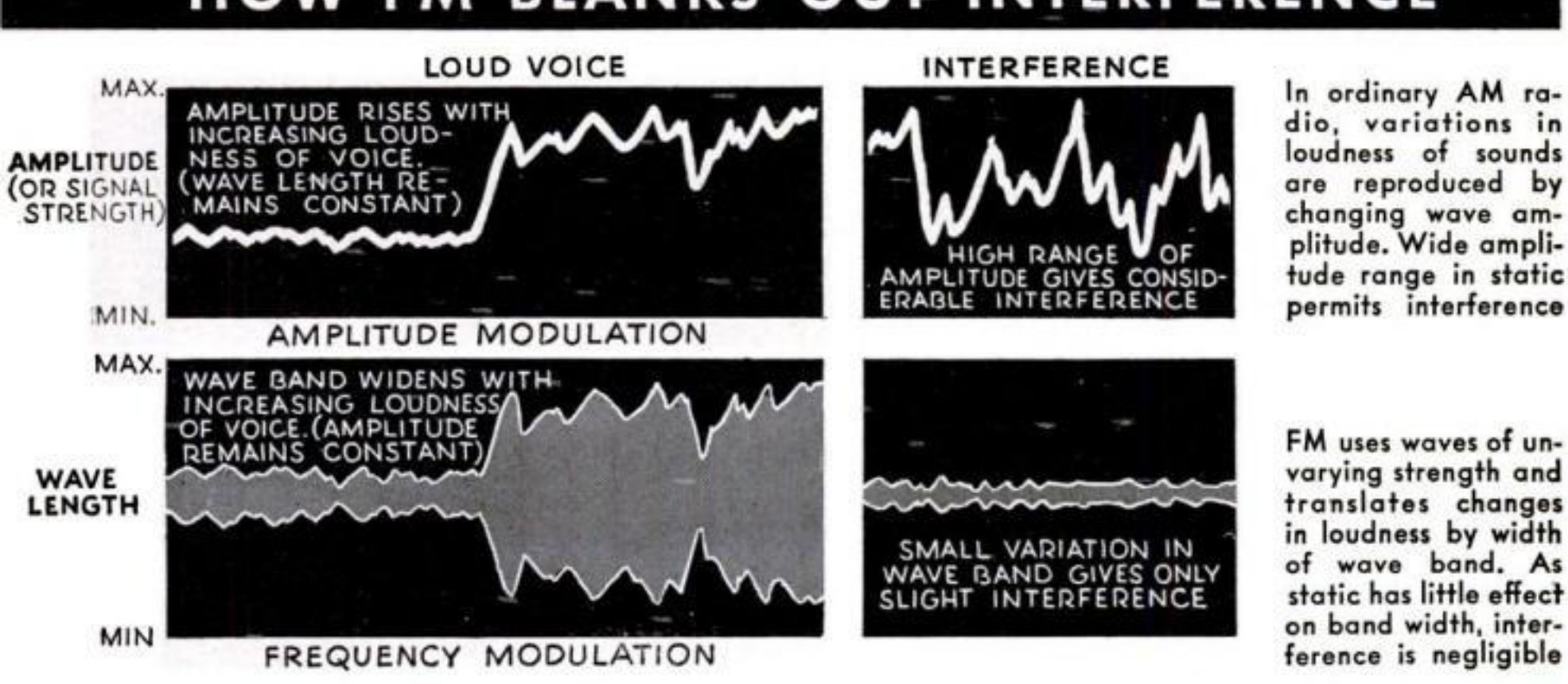
An FM transmitter of the type used in ten stations of the Connecticut State Police, whose police-car equipment served as a pattern for the use of FM by the Army

The dispatcher, sitting at his desk at the barracks, is able to hear both the other stations and the cars in his own area. He may, if he wishes, ground the station-to-station receiver by remote control so that he will hear only a car which is calling him. Police cars can also talk directly with other cars.

Because of the factors of distance and power, the local station is able to control its local cars and blank out all other signals.

One of the Army visitors at the police demonstration asked if the remote-control wires were not vulnerable to saboteurs. The answer to this question by Sydney E. Warner, Radio Supervisor of the Connecticut State Police, reveals another advantage of

HOW FM BLANKS OUT INTERFERENCE



In ordinary AM radio, variations in loudness of sounds are reproduced by changing wave amplitude. Wide amplitude range in static permits interference

FM uses waves of unvarying strength and translates changes in loudness by width of wave band. As static has little effect on band width, interference is negligible

the FM system as it is laid out for police work:

"That is a serious objection where an entire system is dependent upon a single transmitter. However, in this particular system, there is ample overlap in the range of each transmitter so that if, for any reason, one fails, its traffic can be handled through other barracks."

Tests have shown that, in emergency, even a car can be sent to high ground and used us a dispatching point. "Thus," says Mr. Warner, "we also know that even if all our ten fixed stations were put out of service, strategic placing of cars around the state would still enable the State Police radio system to function."

The Signal Corps men saw many tests, including some in cities where ignition disturbance was very high. They were able to listen to both FM and AM receivers in these traffic-congested areas. It was proved conclusively that in nine or ten New York City blocks (about half a mile) AM signals were eliminated by noise, whereas FM signals were perfectly clear over a five-mile distance.

It is easy to see why, after these demonstrations, the Army adapted the Armstrong FM system to its needs. Quickly they visualized the small apparatus made for the police, which could be stowed away in the baggage compartment of a coupe, being efficiently packed in a command car or a small truck, or built into a tank. They imagined the quick automatic tuning being handled, if necessary, by a "rookie." Especially, they saw how signals could be kept from the enemy by limiting the range. They saw that signals could never be confused. They saw, in short, speed, clarity, foolproof operation, and invulnerability.

Another wartime application of FM radio communication has come in the extremely ticklish handling of freight in the railroad yards of Government arsenals where the cars carry immense loads of explosives and where even a slight accident might have terrific repercussions. To see how FM has come to fit here, we should take a brief look at the background of ordinary freight-yard management.

Most Americans would be shocked to see how old-fashioned and primitive this is. Not even common block signaling is used in most railroad freight yards. Old visual signals such as the waving of flags and swinging of lanterns are still in use when they are not stopped by fog. A switching engineer, after he has fulfilled one order, must return to the dispatcher for the next. Accidents in freight yards occur oftener than railroad men like to tell.

When the immense new Government arsenals like Kingsbury and Elwood were projected, the difficulties of a quick, efficient, and safe handling of ordnance freight by common methods was quickly foreseen. At least, thought the traffic engineers, a block-signal system should be installed. But as this was investigated it turned out to be not only extremely costly but its installation would require much valuable time. So the engineers turned to radio for a solution of their problems.

Common AM communication had been tried with long-run passenger traffic. When ordinary steam locomotives were used it worked well enough. But it did not take much imagination to see that any AM receiver installed in a Diesel-electric locomotive such as were planned for the arsenal yards would be stopped by noise. It was then that the FM system came to the notice of the men who were planning the arsenal-yard communications. Today half a dozen Government ordnance plants are being equipped with it.

An example is the Elwood arsenal at Joliet, Ill., whose yard occupies 22 square miles. There are 80 miles of track, 212 switches and 300 of the arsenal's own freight cars. Here nine locomotives will handle trainloads of TNT, artillery shells, aircraft bombs, and antitank mines 24 hours a day.

A 50-watt FM transmitter is controlled (remotely) by the train dispatcher. A similar station is controlled by the yardmaster. From these stations orders are sent out to the locomotives. Each locomotive has a transmitter (25 watts) by which he can talk back to the stations, as well as a receiver.

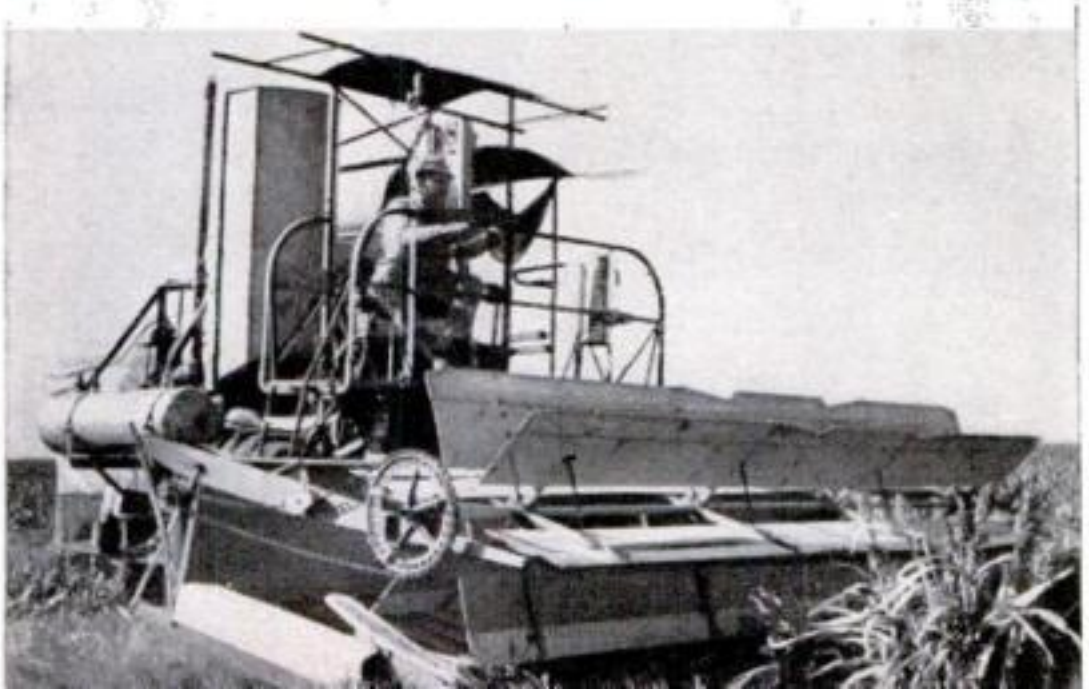
With this kind of communication, any locomotive may be instantly located and controlled. At Elwood there are also gasoline-operated maintenance cars and guard cars. These may be summoned in case of breakdown or sabotage, to any part of the yard.

As the FM radio installation for large freight yards costs less than one tenth of the block-signal layout, it has been suggested that it should be adopted in commercial yards throughout the country. Communications engineers to whom I have talked estimate a 300 to 400-percent speed-up in the handling of freight. With such an increase in efficiency applied to transportation of war material, the impending shortage of freight cars due to steel restrictions could easily be met.

It is always heartening to hear of "new weapons." FM has no direct destructive power. But as a means of multiplying the speed of armies and civilian defense, it is a new aid to all weapons.

Grain drills plant barley in a strip 67 feet wide across a 1,300-acre field on Elmer Von Glahn's huge California farm

This huge acreage is watched over by plane. Acting as his own pilot, Von Glahn will make four or five tours daily during flood season. Below, the newest device to find service in this enterprise of many machines. It is a front reaper for harvesting grain. Ingenious use of implements rivals the work of a large factory

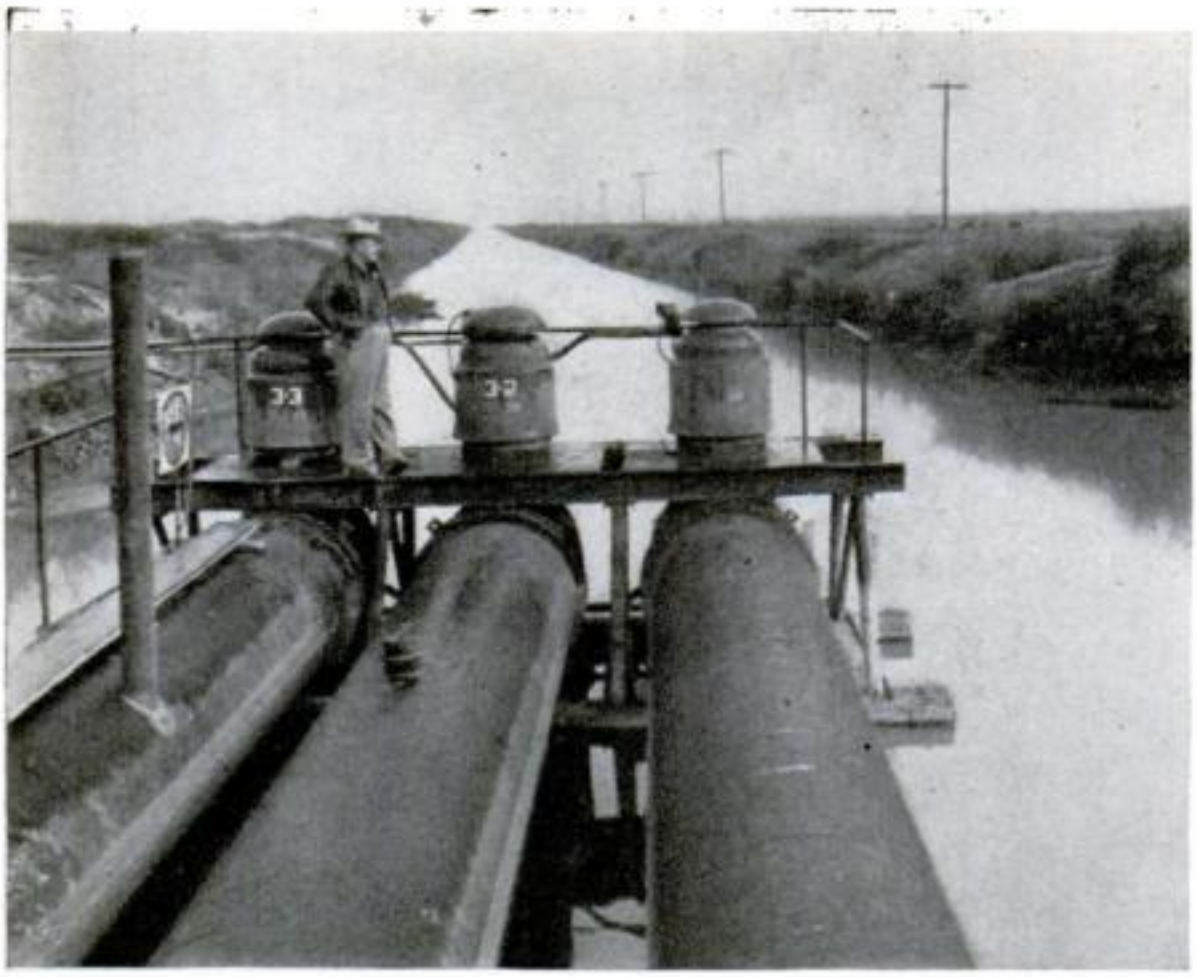


Big-Business Farmer

40,000-ACRE TRACT YIELDS $1,500,000 HARVEST IN A YEAR

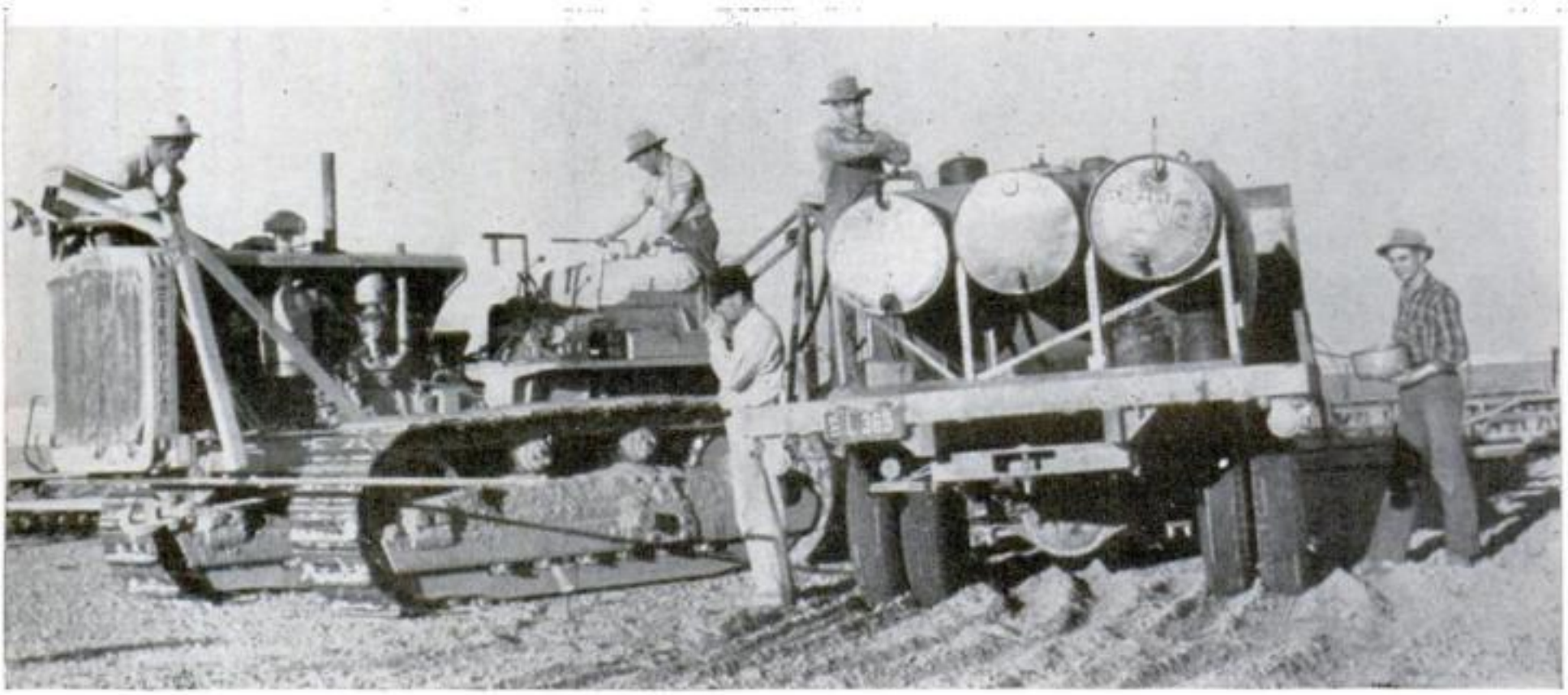
WITH a floating dredge capable of running half a year without refueling, five airplanes, and a fleet of tractors, trucks, and land scrapers, Elmer Von Glahn, a California farmer, will harvest grain and cotton worth $1,500,000 from his farm this year. This 40,000-acre farm in the San Joaquin Valley has been made as fertile as the Nile Valley by the ingenious and intelligent use of machinery, which not only plants and harvests the crops, but keeps under control Tulare Lake, the source of life to the farm yet a constant threat of flood.

On Von Glahn's farm—lying in a 25-mile crescent on the shores of the lake—irrigation is done in a big way. Four huge electric pumps suck up 12,000



Left, Von Glahn looks over one of six pumping stations. An electric pump is checked below by Lawrence Ellison, his water foreman. There are 25 miles of main canals in this system

Three trucks carry gasoline, lubricating oil, and grease to service 36 tractors in the field and keep them running smoothly. A total of 10,000 gallons of gasoline is consumed monthly by the vehicles used in this modern businesslike way of mass-production farming



gallons of water a minute, five other sets lift it 36 feet and fill 25 miles of main canals and hundreds of miles of secondary ditches. Water is turned in on patches as big as 2,500 acres and allowed to stand for 20 days or so at a time.

But this farmer is not content with ordinary irrigation. In a drought, even the deepest canals might fail. To meet this possibility there is ready a wheeled machine which can scoop water from wells and lay it over an acre a day to a depth of from one to 12 inches.

During the flood season, Von Glahn tours his lands by plane. His special machine for flood fighting is a huge floating dredge with a three-yard bucket. It is operated by a two-man crew and can be rushed to any danger spot in the levee for quick repair work before crevices become too large.

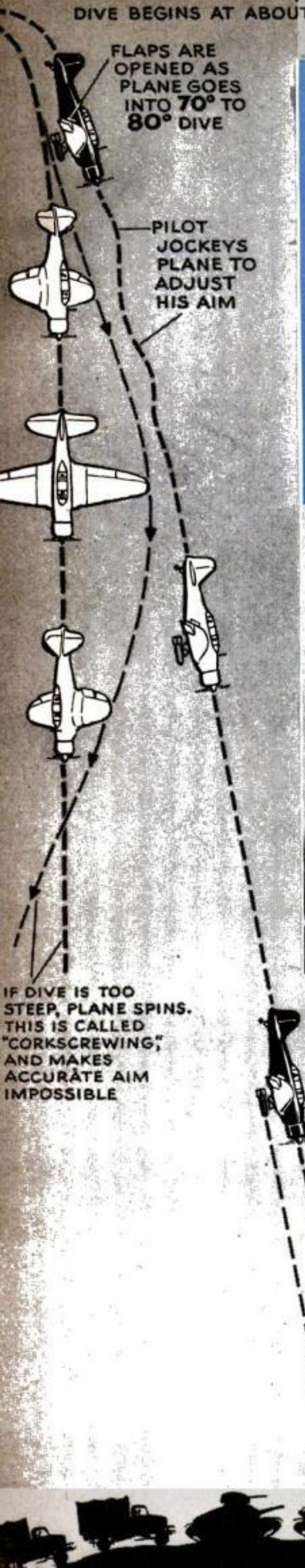
In an elevator and warehouse, one man handles 85 tons of grain an hour as it rides endless belts from the pit. The plant is safely away from the flood area, so that it can still handle neighbors' grain should Von Glahn's lands be flooded.

In the meantime, this California farmer runs his vast tract like a well-ordered industrial plant. He is harnessing the land and cultivating it with machines.

Carrying a six months' supply of fuel, the floating dredge below and at right keeps levees mended when floods threaten. It picks up three-yard loads of rock and mud at the rate of one a minute

The dredge's long boom swings into action when a break occurs, throwing mud and rock from the channel into the opening. Von Glahn named the dredge "Elmer" for himself

Above, hands pour barley or other grain by the sack into big drills, shown on page 87 as they plant the seed. At left, warehouse and elevator through which cotton and grain grown on the land are shipped. The plant was paid for in one year with the saving on grain sacks alone. It not only handles the Von Glahn crops, but those of neighbors as well. Situated safely away from danger of flood, it could continue its operation as a business if the home lands were under water



Lieut. R. E. Strickland initiated the author into dive bombing. As commander of the 8th Squadron, 3rd Bombardment Group, he headed the first dive-bombing squadron to be put into service by the United States Army

An A-24 dive bomber coming in for a landing with its landing flaps open. To brake the plane in a dive and hold its speed within the limits of human endurance and control, double flaps are used—one above and one below the wing surface as shown in the photographs at the right. Perforated with rows of holes, these metal surfaces give firm resistance to the slip stream. The drawing illustrates the part that they play in the dive and pull-out

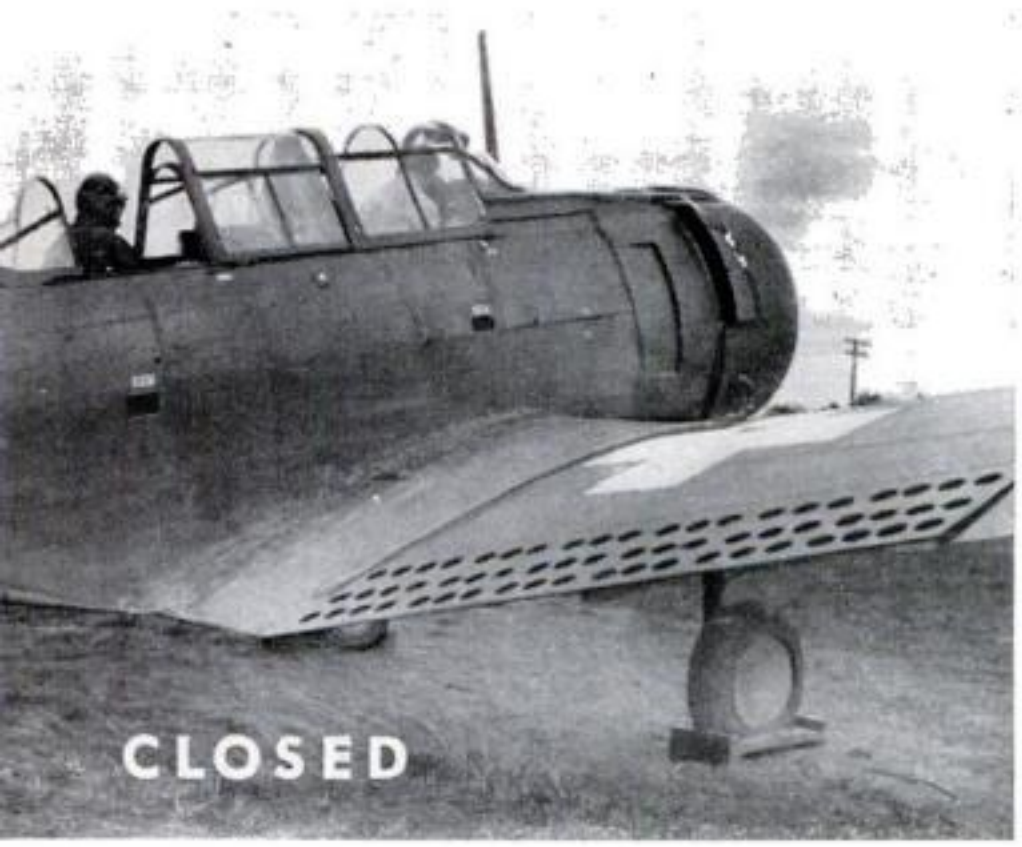
Diving Artillery

HICKMAN POWELL TELLS YOU WHAT IT IS LIKE TO RIDE A DIVE-BOMBING PLANE, AND SOMETHING ABOUT THE MEN WHO ARE READY TO BEAT THE STUKAS AT THEIR OWN GAME

MOST of us probably have wondered, as we follow the war news, what it is like to be a dive bomber. Only a hero can know, of course, how it feels to hurl one's self into the cannon's mouth. But I recently undertook to find out what a dive bomber's job involves, during the training period, and I ran into a number of surprises.

A dive bomber, for instance, is a keen young fellow who eats his greens even more religiously than Popeye the Sailor. He keeps close tab on his weight, but he eats butter in big chunks. Not only is he a perfect physical and mental specimen, but a doctor lives with him in his squadron, as alert to his least symptom as is a mother watching her first baby for a sign of sniffles.

The "blacking out," the violent pull of gravity, and most of the other melodramatic terrors we have been told about diving,



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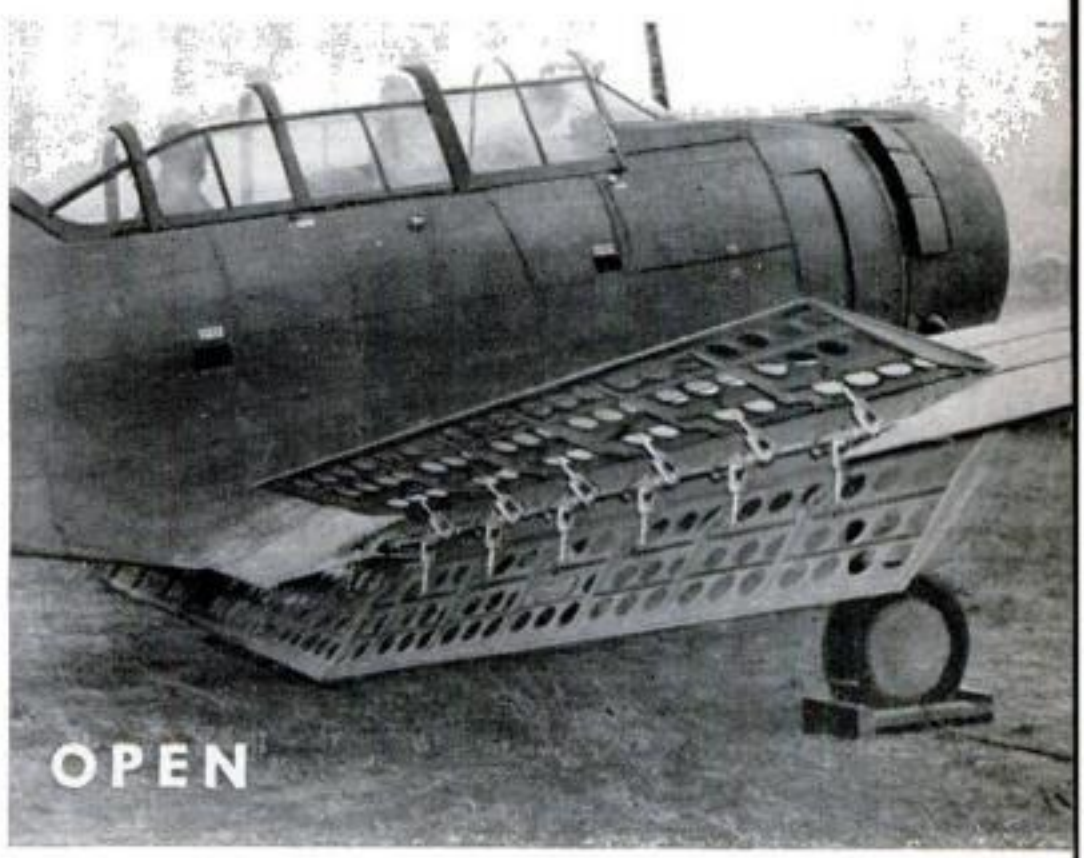
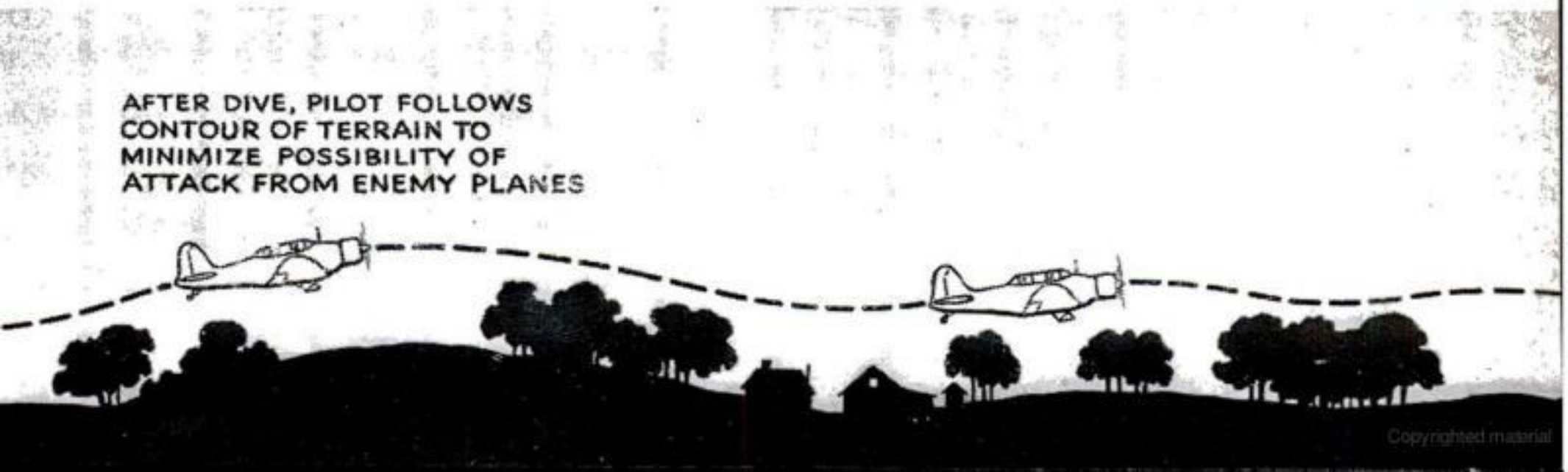
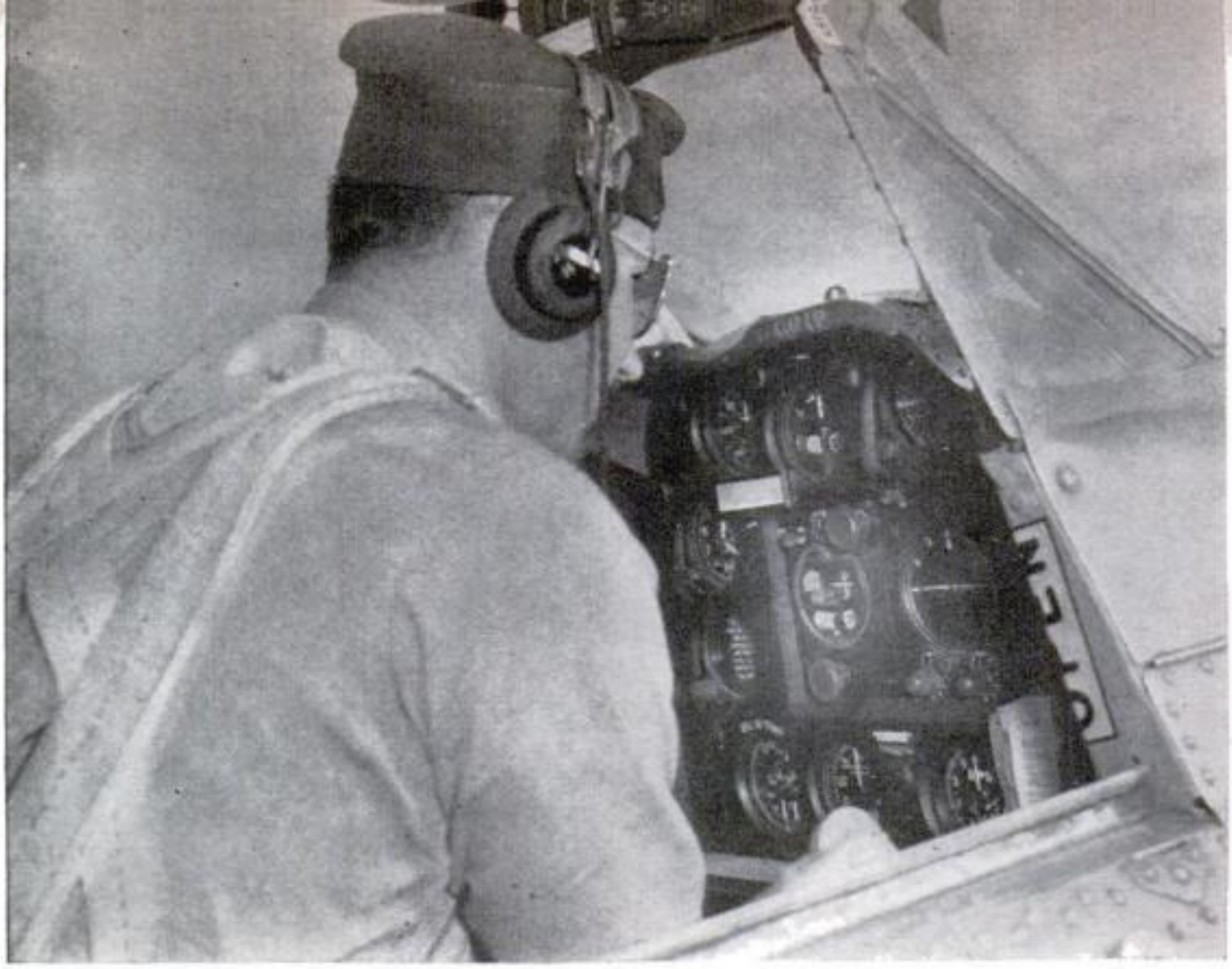


OPEN

AFTER DIVE, PILOT FOLLOWS CONTOUR OF TERRAIN TO MINIMIZE POSSIBILITY OF ATTACK FROM ENEMY PLANES





Greatest enemy of the dive bomber — not counting Japs and Germans — is the common cold. The least cold in the head, or sore throat, swells the mouth of the Eustachian tube or clogs it with mucus — a bad thing in a dive

do not concern the dive pilot very much as he hurtles toward the ground. He is too intent on various wayward faults his plane can develop in its falconlike course. And until he meets a German or a Jap, his greatest enemy is the common cold.

When I arrived at the air field and presented my credentials, Lieut. R. E. Strickland was hurrying out of his tent, buttoning his flying jacket.

"You're just in time, come on," he said. "We've got a mission to bomb a motorized column."

Five minutes later, trussed into a parachute and strapped tightly into the machine-gunner's seat behind Bob Strickland, I was flying at the head of the first dive-bombing squadron to be activated by the United States Army. We were six ships, low-wing Douglas monoplanes from the 8th Squadron, 3rd Bombardment Group (Light). It had taken up its new specialty last summer. As its squadron commander, I suppose Lieutenant Strickland might be called our Army's first dive bomber.

We had flown for a half hour, high over a jigsaw, contour-plowed landscape, when an abrupt lurch of the airplane brought me up sharply to attention. Strickland was looking back at me over his shoulder. He made a quick overhand, downward motion with his hand. Now we were going to dive.

Ever since the Battle of France I had been wondering a lot of things about dive bombing. Now at last I was going to find out the answers. Hurriedly I looked over the side, trying to see our target, but my inexperienced eye was quite unable to identify it in the finely etched panorama 9,000 feet below.

The plane's lurch had been a wobbling signal for the squadron to move into string formation. They were swinging over behind us now, into echelon right.

Suddenly our plane seemed to stop in mid-air. It felt as though a speeding driver had slammed on his brakes. Indeed, that was what had happened. Our diving flaps had opened, pulled us up abruptly almost to stalling speed.

This dive-bombing plane, known as the A-24, has one point which especially distinguishes it from other military ships, and that is the trailing edge of its wings. The inner half comprises two hinged metal surfaces, about a foot and a half wide, which in normal flight are clamped close together. Now some tremendous inner leverage had swung them out, to a sharp angle from the faces of the wing, one above and one below, presenting firm resistance to the slip stream. They acted as brakes, to cut our diving speed to the point of human tolerance and control. The flaps were perforated, colander-fashion, with three rows of holes about three inches in diameter, through which the crowded air could rush. The inner surfaces were painted red and against the black-green of the plane's back they had a living look, as though they might be the distended gills of a hammerhead shark lashing in for the kill.

I got ready to hang on. I rested my forearms on a convenient metal hoop in front of me and leaned forward. I planted my feet wide apart, well away from the dual-control pedals which moved between them. Backseat driving would hardly be appreciated now.

An important man in a bombardment group is the flight surgeon (center), here irrigating a pilot's ear. Like the trainer of a football team, he must keep a constant check on the health of his charges — with special emphasis on the vital ears, nose, and throat

In his ambulance the flight surgeon has a complete portable "doctor's office" which can be set up in a tent at any base from which the squadron operates. At right, he checks up on a "patient's" throat

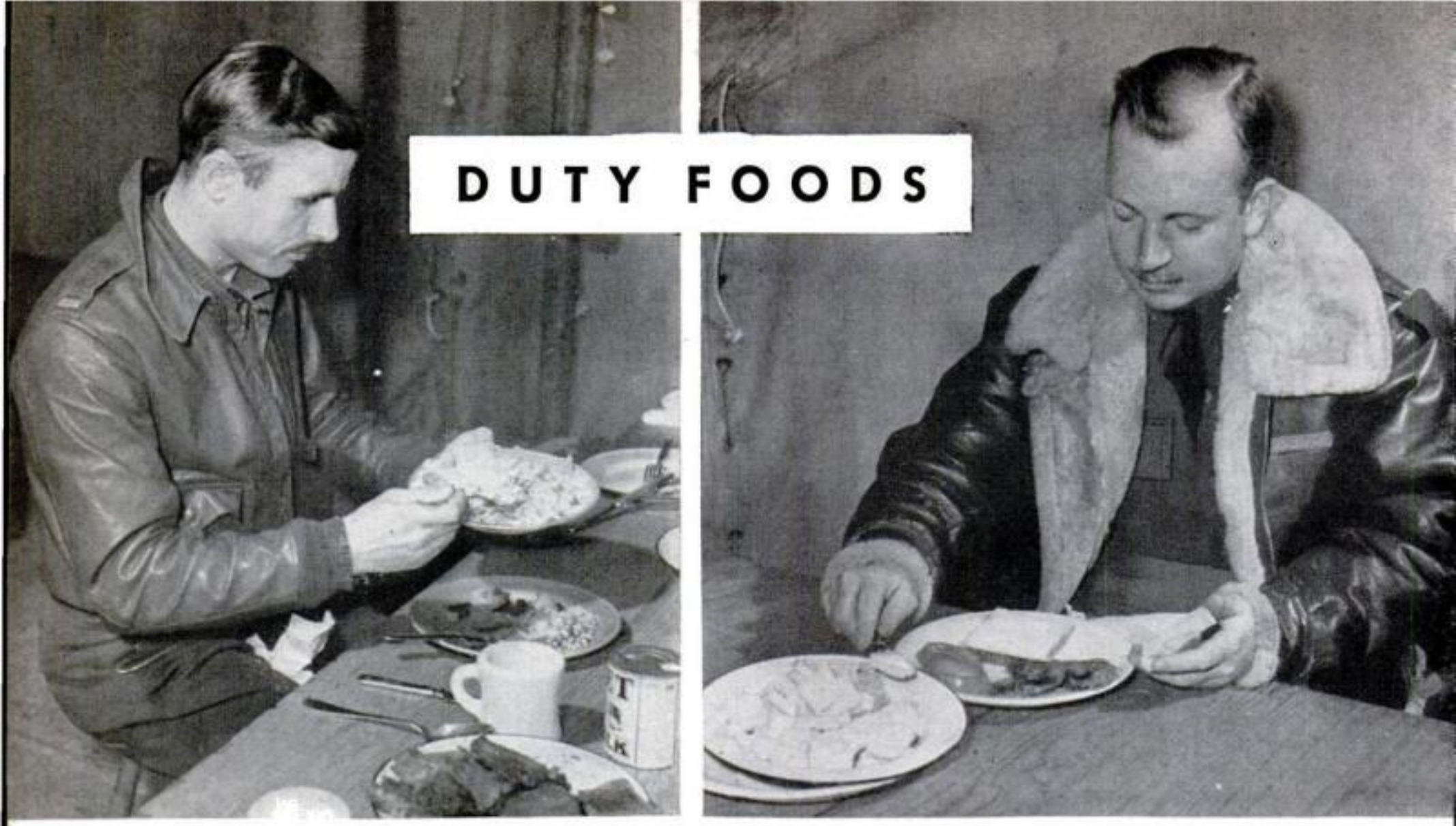
We nosed over, then pulled up sharply and ran forward again for an instant. Now we nosed over again, straight downward, like a canoe going over a waterfall.

There was a confused sensation of not weighing anything. Pressure pounded in my ears, and I swallowed hard to relieve it. I was surprised not to feel that yawning unpleasantness in the abdomen which always comes when an elevator drops too fast. I glanced at the racing needle of my altimeter, and we had dived 3,000 feet before the glance was finished.

Looking ahead to see the target, I found myself staring merely at a bulkhead and Strickland's head and shoulders. We had dropped a mile before I realized the place to look was over his head, out through the top canopy, where the sky should be. The solid earth was close looming, rushing up upon us.

Our nose began to pull up. Now everything was pushing upward against my sagging muscles. My pillowed parachute became hard. Arms and feet were straining under a suddenly terrific load. Some inexorable force was pushing my head down, downward, chin into chest. My radio headset fell off heavily, and a rushing roar engulfed me. It was about a four-G pull-out, they told me later. That is, centrifugal force and momentum had multiplied the

DUTY FOODS



Dive bombers eat their greens more religiously than Popeye the Sailor, and consume butter in big chunks. Carrots, too, provide the vitamin-rich carotene that helps adapt the eyes for night fighting

usual pull of gravity by four times. For an instant I had weighed 660 pounds.

It was over quickly. The plane was slanting downward gently and back over the side our target could be seen. It was a train of personnel carriers, armored cars parked along a roadside. Soldiers were standing up in them, unprotected, rubber-necking at the planes. Theoretically the carnage was terrific.

But it was a sight worth staring at. The second plane was just pulling out at 1,500 feet, the third was half way down, while a fourth was poised to strike. Down they came like rockets in reverse.

Just how fast they were coming I don't know. Maybe it had taken 20 seconds to dive a mile and a half. That would be about 250 miles an hour. It had seemed a lot quicker.

Flaps closed and speeding, our planes were skimming the tree tops now, pulling into formation. Hedge-hopping, grass-cutting, skipping through the dew, hardly 20 feet above the foliage. Down close to the ground was the safest place to be for an escape.

Dive bombing was invented by the U. S. Navy, back in the 1920's, and was developed secretly for some years. In 1932 somebody let the cat out of the bag, and the idea was seized by the German Luftwaffe, to be used with devastating effect in the land offensive of May, 1940.

To most of us dive bombing was then a new and terrifying thought, but it was nothing new to our Army airmen and they remained convinced that for ground strafing against troops their own method of light bombardment was better. They had developed a low-flying, twin-engine ship, now known as the A-20A (called the Boston by the R.A.F.), especially adapted to appear surprisingly over a clump of trees or a ridge of land, sprinkle a large load of cream-puffs from an altitude as low as 75 feet, and disappear while the enemy was still surprised. In another heavily armed form, known as the Havoc, this same ship has become the most effective night interceptor the British have.

Developments supported this American judgment to a great extent. While low flying soon demonstrated its value, the German Stukas proved relatively ineffective where local air superiority had not been obtained. They had been so successful in France because no strong pursuit forces were against them. Also they were vulnerable to antiaircraft fire.

But still diving had its definite usefulness, against moving targets, and especially for carrier-based craft against warships. Our Navy developed it to the utmost. Meanwhile the Stukas continued to prove their value in attacks on British vessels in the Mediterranean. Last year our Army began using dive-bombing squadrons, borrowed from the Navy, in all its maneuvers. A part of that development was this pioneer squadron, equipped with Navy-type planes, with which I had now been flying.

Those few seconds of diving had demonstrated a lot. For instance, without our own fighters to protect us, we would have been easy prey for enemy pursuit ships as we

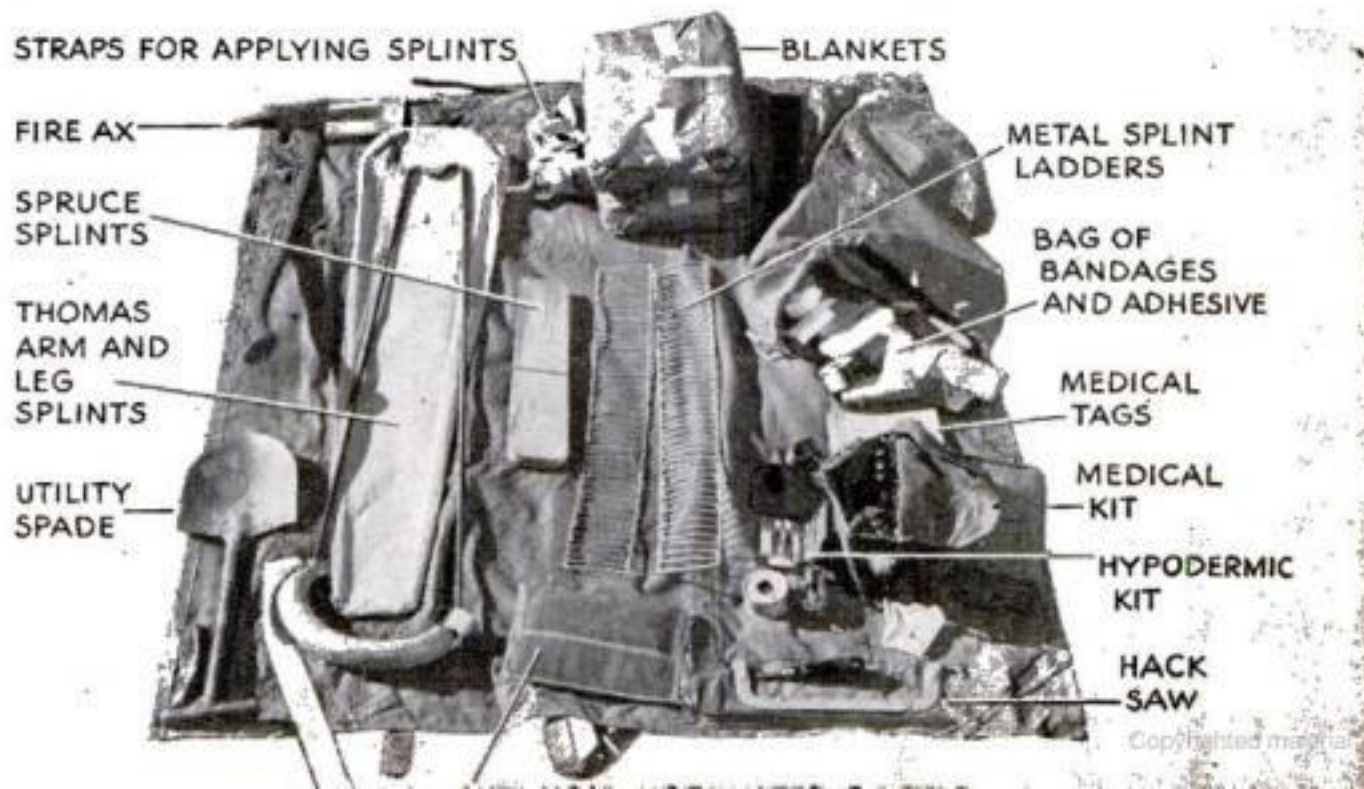
Alongside the ambulance, a crash truck stands ready with its trained crew on the alert whenever planes are in the air. In case of an accident it dashes to the scene of the crash to rescue the flyers

Equipment of the crash truck includes fire-fighting and rescue tools, all arranged for quick use. The crew is drilled for perfect teamwork in emergencies

This is the first-aid kit that goes out with the rescue crew. Its contents, shown in detail below, are chosen and arranged to meet any contingency

came in and poised for the dive. And a cool machine-gunner directly below would have had a very good chance to knock us off. The Stukas have found that out. But of course if there had been more of us, diving from various directions, the odds on our side would have been improved.

Certainly there is no need to minimize the velocity and tension of such a dive as this, but a good many melo-



dramatic notions had fallen by the wayside too. For instance there was the matter of centrifugal force. From what I had heard of this kind of flying I had half expected to black out as we pulled up from the dive, but that proved to be an exaggerated notion.

The black-out is a common thing in some types of aviation. When a plane makes a sharp turn at high speed, the centrifugal force is such that the blood is drawn away from the pilot's brain and everything goes black. He becomes blind for the moment and if the strain continues he goes unconscious temporarily. A pursuit pilot expects to black out several times in an ordinary day's rat race, but a dive-bombing pilot doesn't black out unless he is in bad physical condition. It is not so bad to go unconscious in a bank at 15,000 feet, but it's a different matter altogether if you are at less than 1,500 and roaring straight for the ground.

Probably the greatest problem of flying nowadays is that machines have developed beyond the ability of human beings to endure them. This is typified by the ability of engines to operate efficiently at an altitude where humans almost instantly die without an oxygen mask and are oxygen-starved even when breathing the gas in pure form. So also an airplane's wings can stand more G's of centrifugal force than can its pilot. A healthy young man can generally stand up to about five G's for two or three seconds without blacking out. The braking flaps of the diving plane have slowed it down so that, at four G's, the black-out danger is averted and also the ship can be precisely controlled by a young man so well in tune that his reactions are almost instantaneous.

At luncheon after our bombing expedition the pilots told some of the things they had been doing during those tense seconds of the dive.

The most difficult thing was to trim ship. The whirling propeller, driving an airplane, develops torque, a twisting reaction which tends to turn the ship to the left. For normal flight the stabilizer is set permanently at an angle to counteract this. But in a dive the propeller no longer is driving the plane and the torque is abated. So the off-center stabilizer throws the ship into a skid. That is, the tail slips off to one side.

Now, the whole principle of dive bombing is that the plane itself is aimed at the target, with a telescope sight which runs parallel to the longitudinal axis of the ship. If the ship is moving in one direction and pointing in another, aim is thrown completely off.

"In a dive you're practically standing on your left rudder," said the youngster sitting next to me. "That corrects the stabilizer and stops the skid. You've got to keep the ball centered. You see, the bank indicator on your instrument board has a ball in a curved tube, and if the plane is skidding that ball rolls off center."

While thus trimming ship to avoid a skid, the pilot must also select the proper angle of dive. The sight is set to work with reasonable accuracy at an angle between 70 and 80 degrees. Remember this is degrees and not a percentage. An 80-degree dive is about 89 percent of a true vertical angle. Coming on his target, the flyer picks his moment and noses downward. Probably his angle is now a bit shallow, so he pulls up and runs forward a bit. He may perform this trial-and-error process several times in the first 1,000 feet of descent, before he attains the proper steepness and lets loose the all-out plunge.

The dive is likely to begin around 70 degrees and wind up at 80. But if his angle gets much steeper the pilot is in trouble. The wings lose their hold on the atmosphere and the ship begins to rotate. Corkscrewing, they call it. The whole earth seems to whirl, and in a crazy eccentric fashion, for the pilot's sight is of course not at the axis of his rotation. Aim is lost, and in pulling out of the dive the pilot has also lost his sense of direction, which may be embarrassing in a battle.

Diving is easier into the wind than with it, because a tail wind may carry the plane into too steep an angle. It may even carry the ship beyond the target, so the wing load is reversed. But a good pilot has to learn to dive from any direction.

Having trimmed ship and got the proper angle, the pilot's next job is to look through his sight and hold his cross hairs right on the target until, at about 1,500 feet, he is ready to release the three bombs suspended under his wings and fuselage. One hazard developing at this moment, sometimes called target fascination, is that the pilot finds himself glued so fast to the target he can hardly force himself to pull off. Those reporting this difficulty, however, have always been able to master it.

In lunching with these pilots, I noticed how much colorful food there was on the table. Servings of butter were several times the usual size, and it was very yellow butter. There were raw carrots, green vegetables, lots of salad.

"I don't like *(Continued on page 220)*

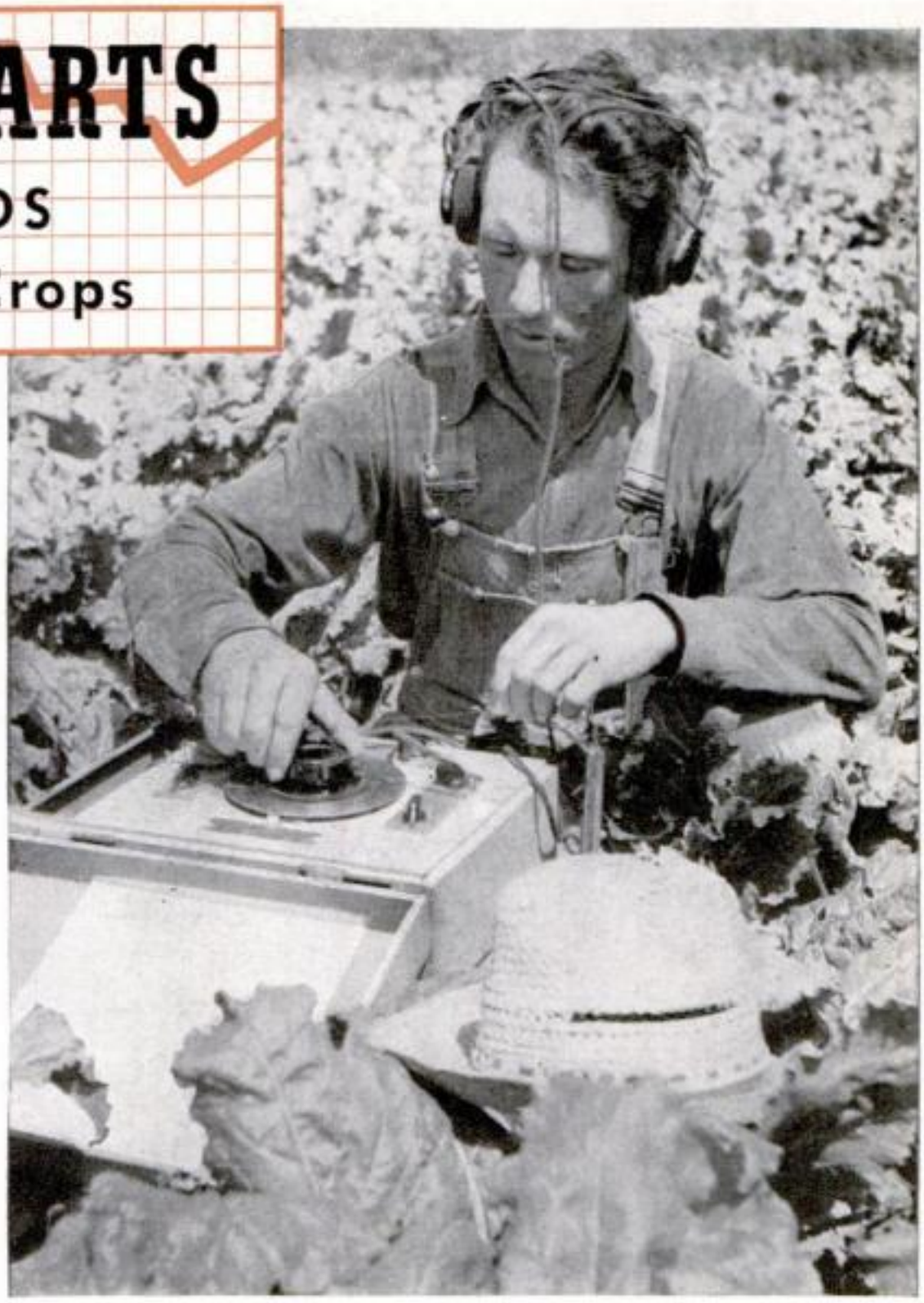
FEVER CHARTS
FOR FIELDS
Boost Farm Crops

IF YOU should hear a man talking about the "fever chart" of a field of growing crops, you might wonder if his own temperature did not require looking into. But field "fever charts" are a new and very vital factor in the all-out American crop production needed to win the war. They are especially vital in the Western states where there are millions of acres of irrigated agriculture, and where knowledge of the exact moment to turn on water, and how much, may result in a difference of 10 to 20 percent in the size of the harvest and much difference in its quality.

The apparatus, which does not register temperature, but relative moisture of the soil, consists of a domino-size block of porous plaster of Paris in which are set two wires that do not touch. This block is buried in the ground, the wires leading to an instrument which is a modified Wheatstone bridge. When current is sent through the block, the amount of resistance can be used to measure the moisture content of the soil, which is exactly that of the block.

The instrument was worked out by G. J. Bouyoucos and A. H. Mick, of the Michigan State College Agricultural Experiment Station, and tested in a big way by the Great Western Sugar Company and other large processors of irrigated crops with the assistance of the farmers in the field.

The meter has its uses outside the irrigated areas as well. For one thing, coupled to an automatic sprinkler, it can be used to turn on water in parks and vegetable truck gardens.



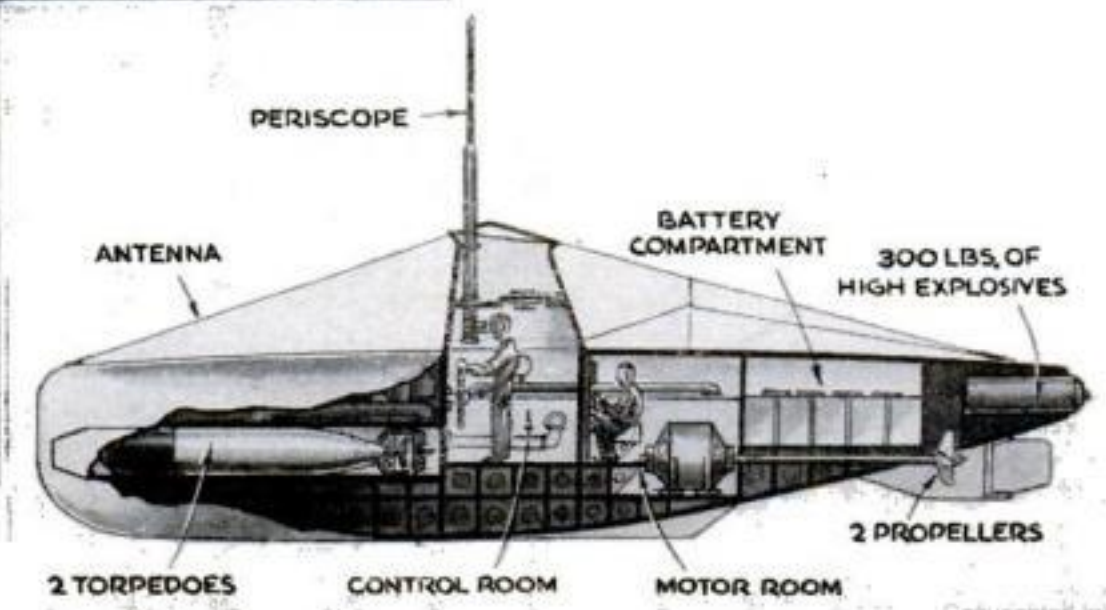
Reading the moisture content of a growing field. Irrigation turned on at the proper time helps to make maximum war crops

Below, holes are bored at varying depths and small blocks of porous plaster of Paris sunk in the soil. Electric wires from them to a meter above the ground record the relative moisture

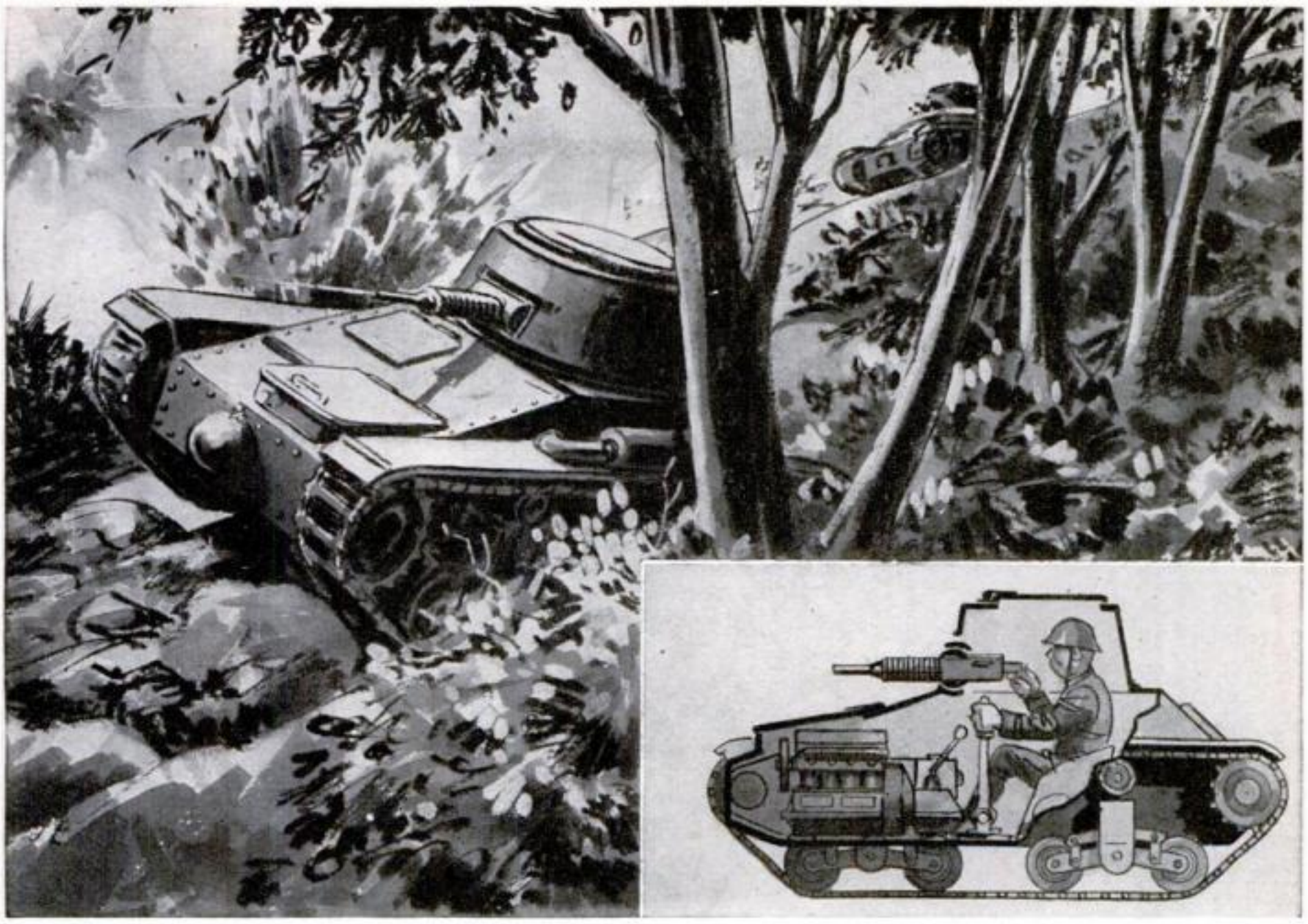
TWO-MAN GUN CARRIER is one of several "vest-pocket" weapons developed by the Japanese. Intended for tropical fighting, it can penetrate light jungle growth, and rice and rubber plantations. While dangerous in large numbers, it is vulnerable to antitank guns and to aerial bombing and strafing

NEW AXIS WEAPONS

WHEN the U. S. Navy captured its first enemy warship, during the Pearl Harbor attack, it verified one of a number of persistent reports of new Axis war weapons. The beached craft proved to be a midget Japanese two-man submarine, intended for suicide attacks at short range. Examination showed that the type measures 41 feet long, with a stubby conning tower and periscope. It carries two undersized torpedoes, plus a 300-pound explosive charge to blow up the submarine



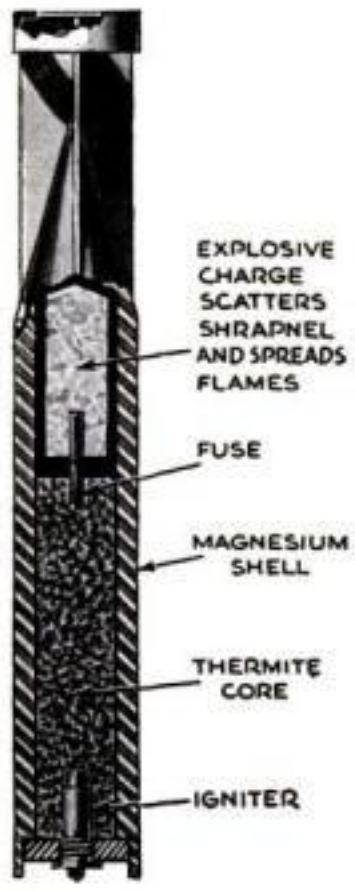
"HUMAN TORPEDO" At the left is an American version of a torpedo craft that throws its pilot overboard just before striking a target. Below, diagram of a two-man Japanese submarine captured at Pearl Harbor. Note explosive charge carried at stern



ONE-MAN TANK used by the Japanese in the Malayan campaign is a great help to landing parties. While they are no match for heavily armored vehicles, the lightweight machines offer a serious threat in mass attack, where they lead infantry in attempts to pierce the opposing lines. Inset shows the interior

itself and anything near it. Driven by electric motors alone—standard craft use Diesels on the surface to save and recharge the batteries—the midgets have a low-speed cruising radius of no more than 200 miles. But they are small enough to be carried on the decks of a surface ship, and lowered into the water near their objective. Their first trial, at least, was a failure; one went aground and another was detected and sunk when the pair attempted to slip into the harbor.

A one-man tank, another "pocket" Japanese weapon, has taken part in fighting on the Malay Peninsula. In these lightweight machines, the driver serves as his own gunner. Vulnerable to antitank fire, they nevertheless are well suited to landing operations, and may constitute a serious threat by sheer weight



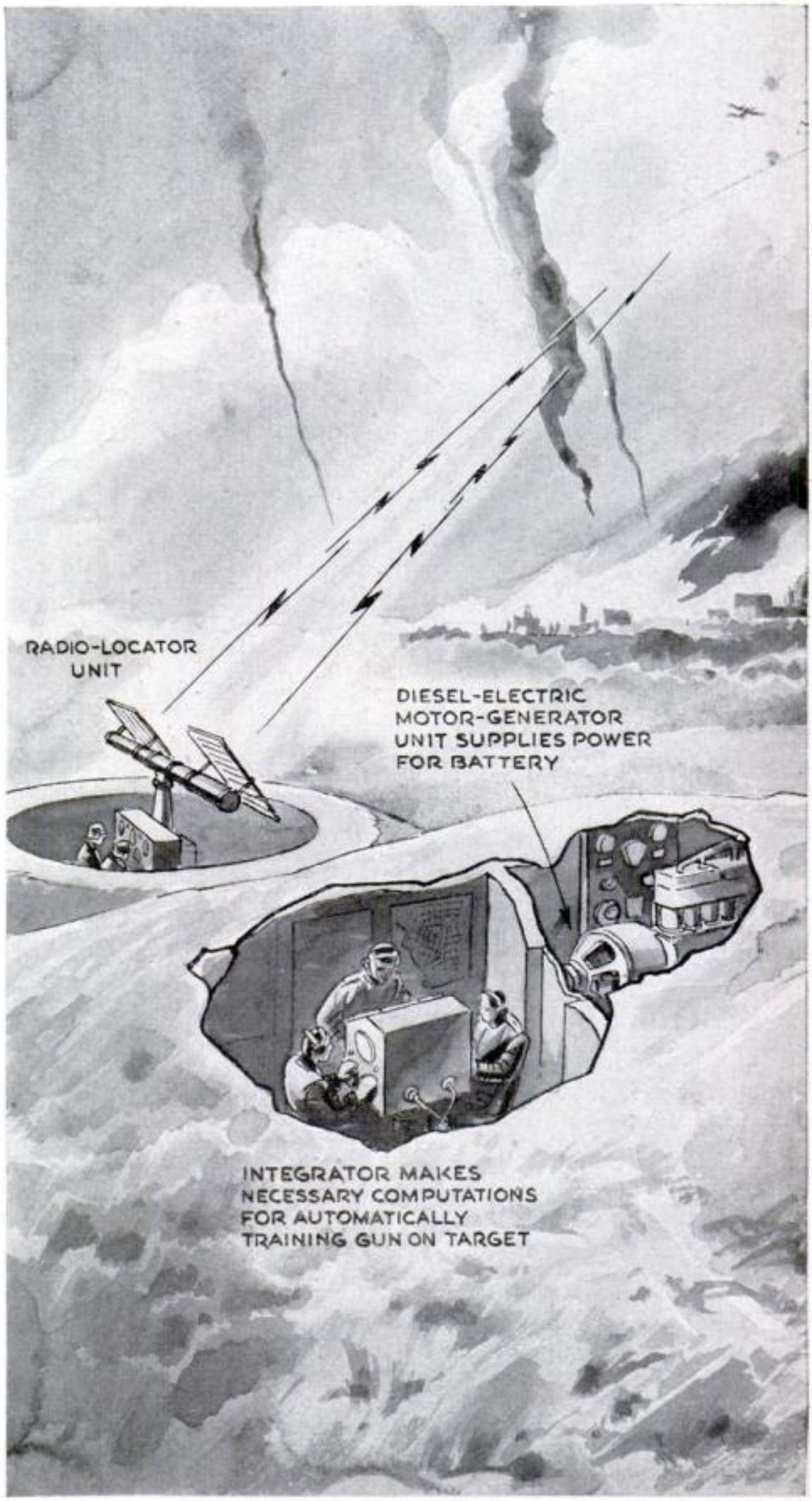
Incendiary bombs credited to the Germans contain delayed explosive charges. A few mixed with regular bombs would make people afraid of all incendiaries

of numbers. Likewise, a two-man Japanese gun carrier sacrifices armored protection for ability to negotiate jungle terrain.

From the European theater of war come reports of other military novelties. As Germany begins to pass from the offensive to the defensive in the air, it appears to have developed a new type of installation for antiaircraft defense. Radio locators developed in Germany and other countries have already made it possible to detect invisible air raiders, and, through an electrical brain called an integrator, to transmit firing data to the gun crew. A current refinement is said to make the guns respond automatically to the firing data, training themselves, setting shell fuses, and firing of their own accord as long as the radio locator is "on target." One of the few sources of human error is thus eliminated, and the duty of a reduced gun crew becomes simply to keep the magazine filled with ammunition.

On the offensive side, incendiary bombs with delayed explosive charges have been ascribed to German technicians. Outwardly resembling standard fire bombs, which Britishers have learned to handle and remove from buildings, the combination type burns for a short time and then explodes. Complicated to manufacture, it probably would not be used on a large scale; but a few of these bombs mixed with those of standard type would be calculated to make persons keep away from all incendiary missiles, while they served their purpose of starting fires.

A "human torpedo," reportedly tried unsuccessfully by the Italians at Gibraltar, may be a development from the previous



AUTOMATIC AIR DEFENSE
Artist's conception of a new German antiaircraft installation in which the guns respond automatically to firing data. The radio locator spots planes hidden by clouds or distance and the integrator computes firing data for transmission to the guns, which aim themselves, set their own shell fuses, and keep on firing as long as the radio locator is on the target. There are no dials or controls as on other antiaircraft guns, and the small gun crew has nothing to do except feed shells into the magazine. When the locator gets off the target, the guns cease firing

Drawings by
B. G. SEIELSTAD

World War. At that time, two Italian officers straddling a compressed-air "torpedo" managed to penetrate the defense of Pola Harbor and detach warheads that sank two major Austrian naval vessels. An American inventor, Otto Frindt of Chicago, has modified the idea in a gasoline-powered, human-piloted torpedo that automatically tosses its rider into the water before striking its target.

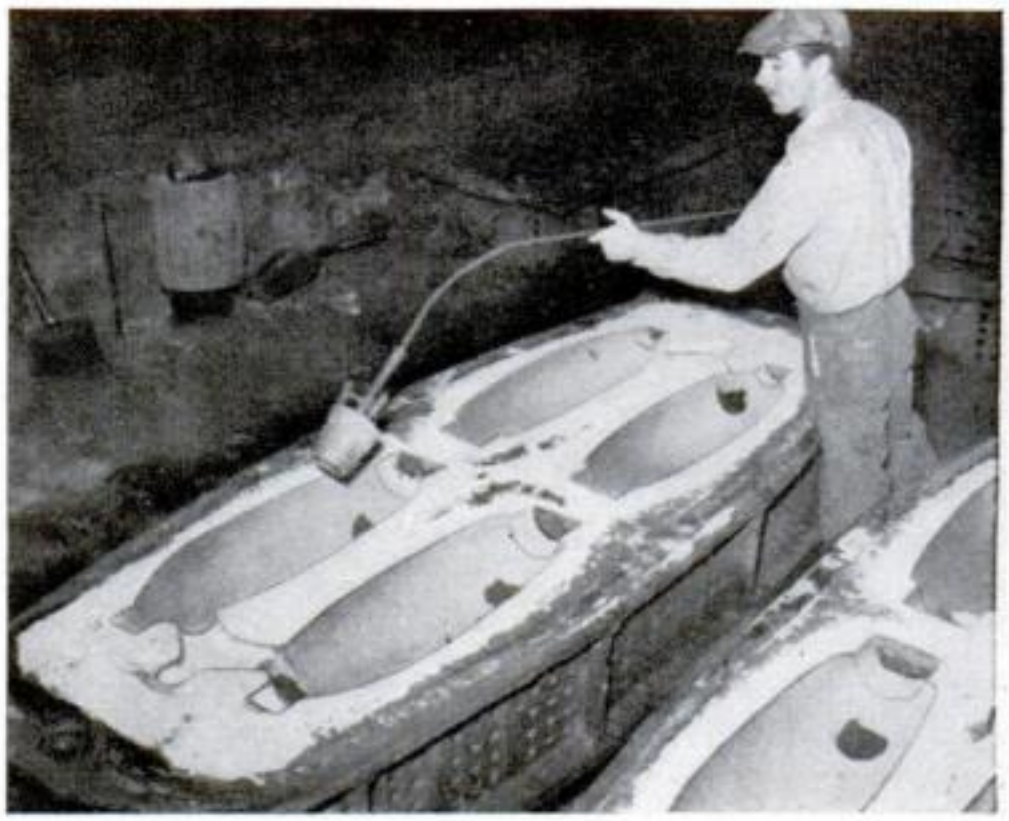
And whatever other war innovations the Axis may have for us, it is a pretty safe bet that Uncle Sam has some surprises up his own sleeve, ready for use when his land, sea, and air forces come to grips with the enemy in any part of the world.

This is a finished 250-pound cast-steel bomb casing, ready for shipment to a plant where it will be fitted and loaded. These photographs show how such a casing is made

CASTING

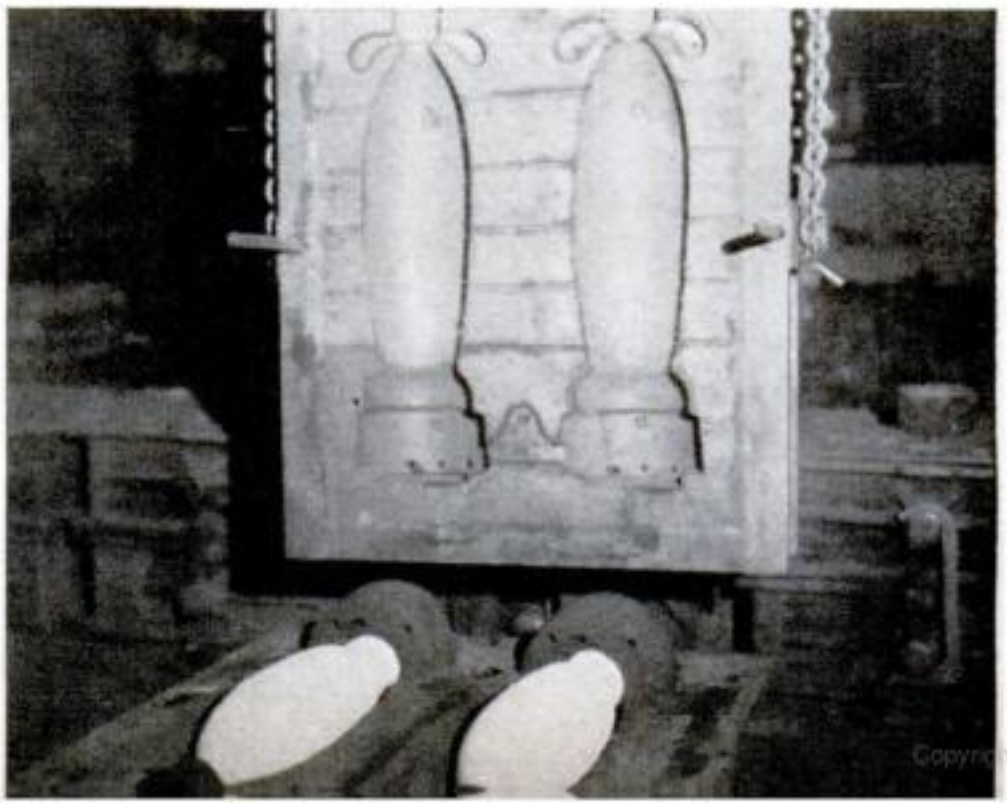
Those thousands of bombing planes we are building wouldn't be much use without bombs, so foundries are busy making cast-steel casings to hold the explosives that give the bomber its sting.

1 Molds are skin-dried with a natural-gas flame to keep any moisture from coming in contact with molten metal. This is a cope mold for four casings. The small spots in the mold are vent holes that allow gases to escape

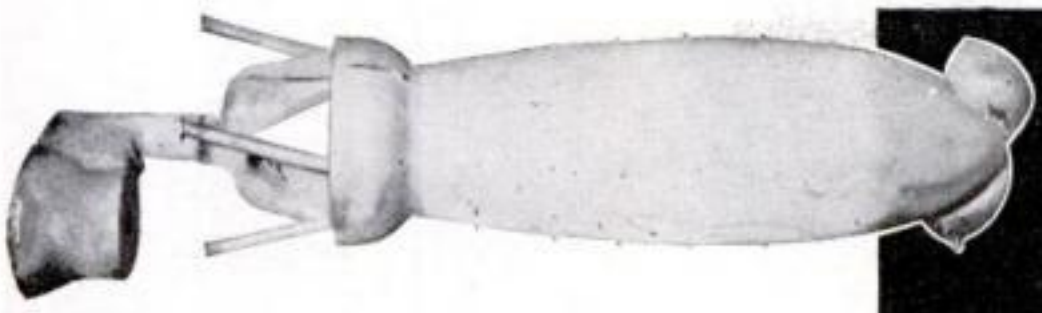


2 Making a core for shaping the interior of a casing. While the coremaker rams a core, his helper sprays one already made. Finished cores on the rack in the background are ready to go to the drying oven and the molding floor

3 Here is a drag mold with cores in place, and a cope mold ready for closing onto it. Molten metal flowing around the cores inside the mold will form the bomb casings. The cores owe their bright white finish to the refractory coating which enables them to withstand heat

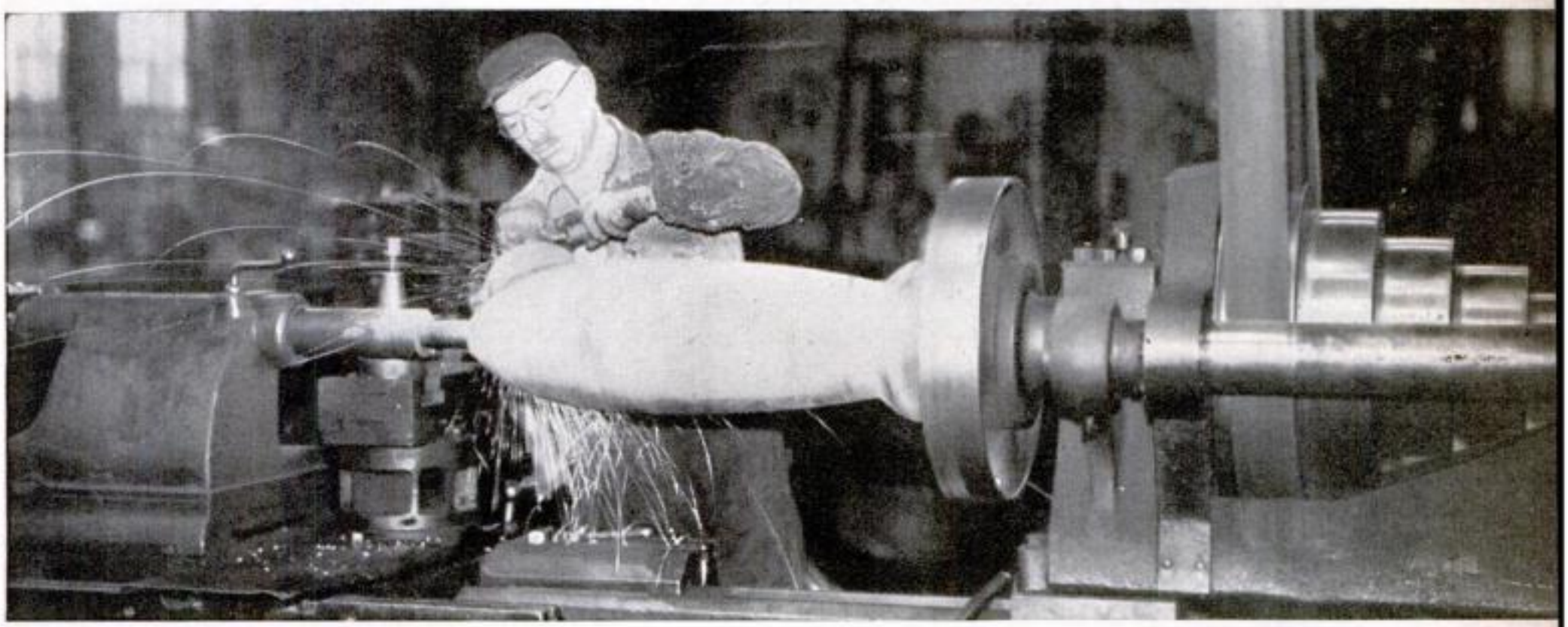


THE EGGS OF WAR



4 When it comes from the mold, the casing looks like this, with "gates" remaining where metal was poured into the mold, and "risers" where gases escaped. Sand-blasting removes surface roughness

5 In the finishing department, casings are placed on conveyors where they are inspected and then passed on to the chippers who remove all excess metal from them with pneumatic tools. The gates and risers left in casting have been taken off

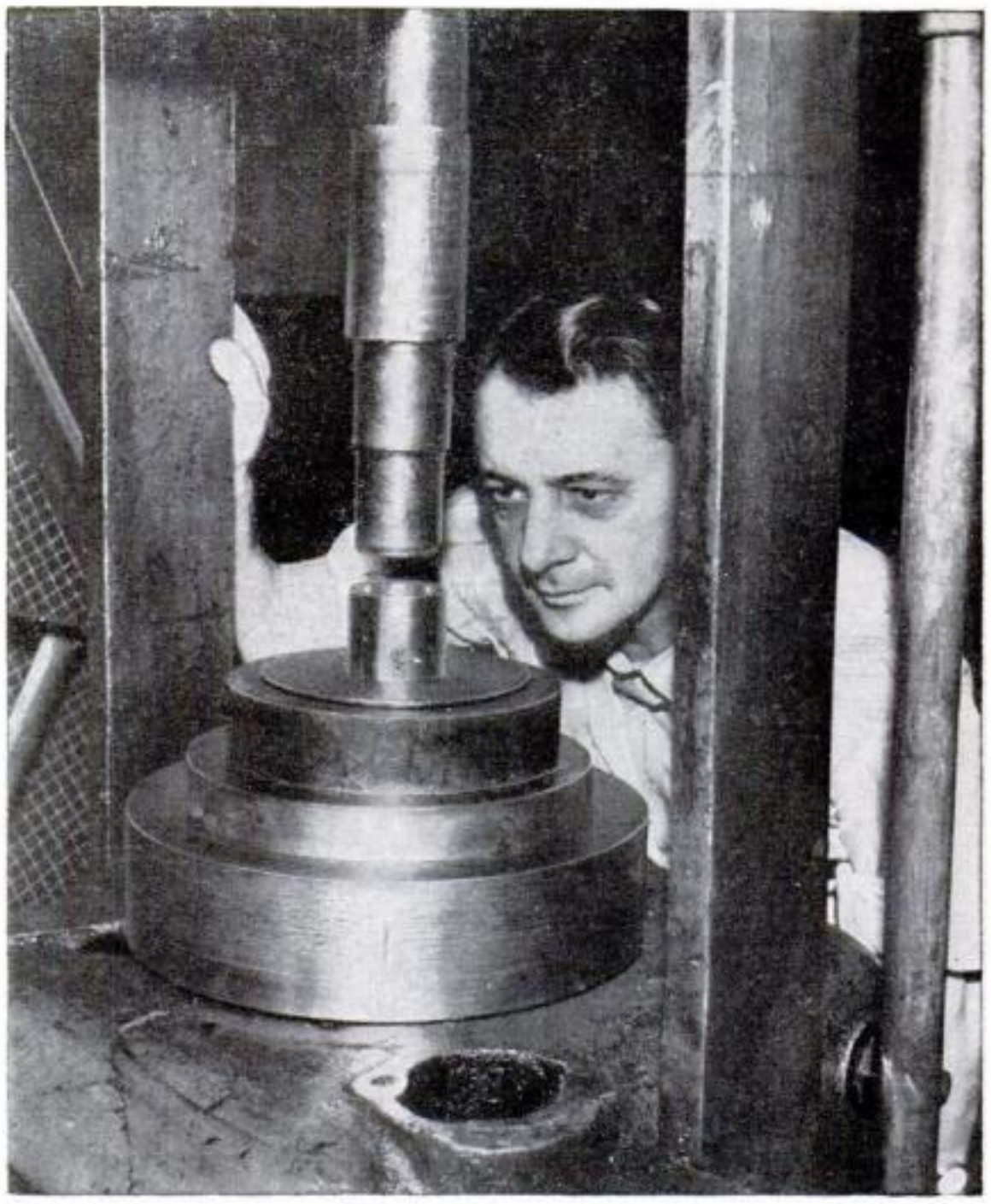


6 Now the casing goes on to the grinder to be ground smooth. Placed in a lathe, it is finished with a hand grinding tool. The next step is to machine the casing to receive the tail-fin assembly and other fittings it will be given later

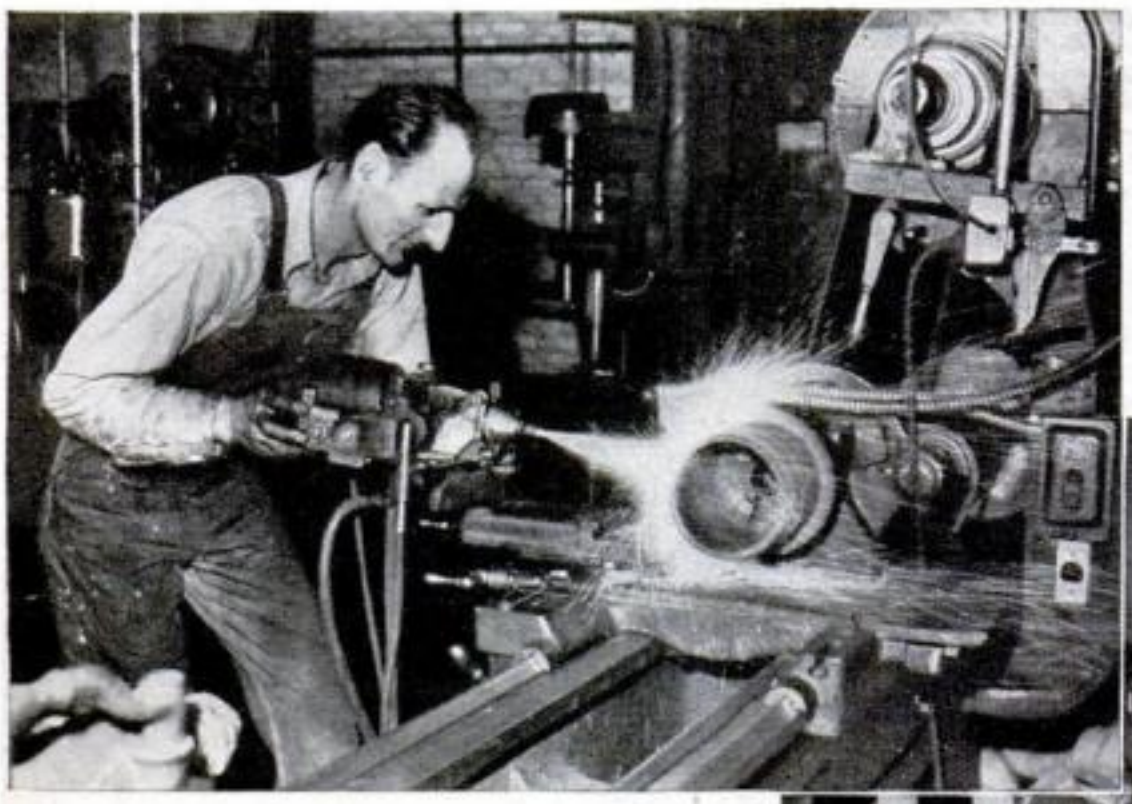
7 Below, inspectors are testing the tail-end threads into which tail assemblies will be screwed when the bombs are loaded. The foundry's job is ended when the empty casings are approved and instructions are received for their shipment

SQUEEZED BUSHINGS SAVE COPPER AND TIN

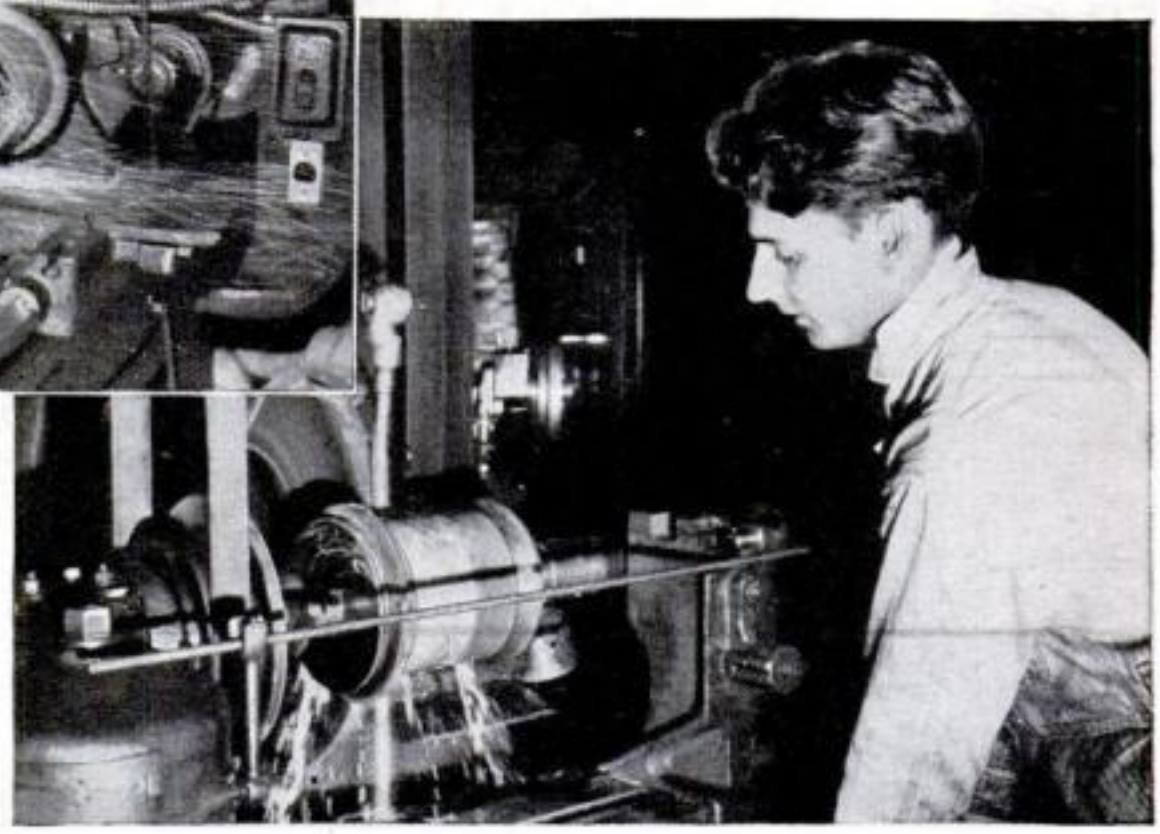
PUTTING worn-out bronze machinery bushings back in shape by a process of his own devising, A. V. Berry, of Los Angeles, Calif., has built up a novel and paying business. Currently, however, its prime importance is its saving of tons of the strategic war alloy of copper and tin formerly discarded. When a bushing—the "shell" in which a shaft, or journal, turns—comes in for overhaul, Berry first cleans it with a hot chemical, after which a steam bath sweats out oil imprisoned in the metal. Next, the bushing is placed in a press over a tapered die through which it is quickly forced by a 10-ton plunger. This reduces the inside and outside diameters of the relatively soft bushing. Subsequent steps achieve resizing of these diameters. The outside is made rough with a special tool, then literally sprayed with atomized steel from a gunlike device as the bearing is revolved, building up a steel backing. Both the backing and the inside surface finally are ground by conventional methods to desired diameters.



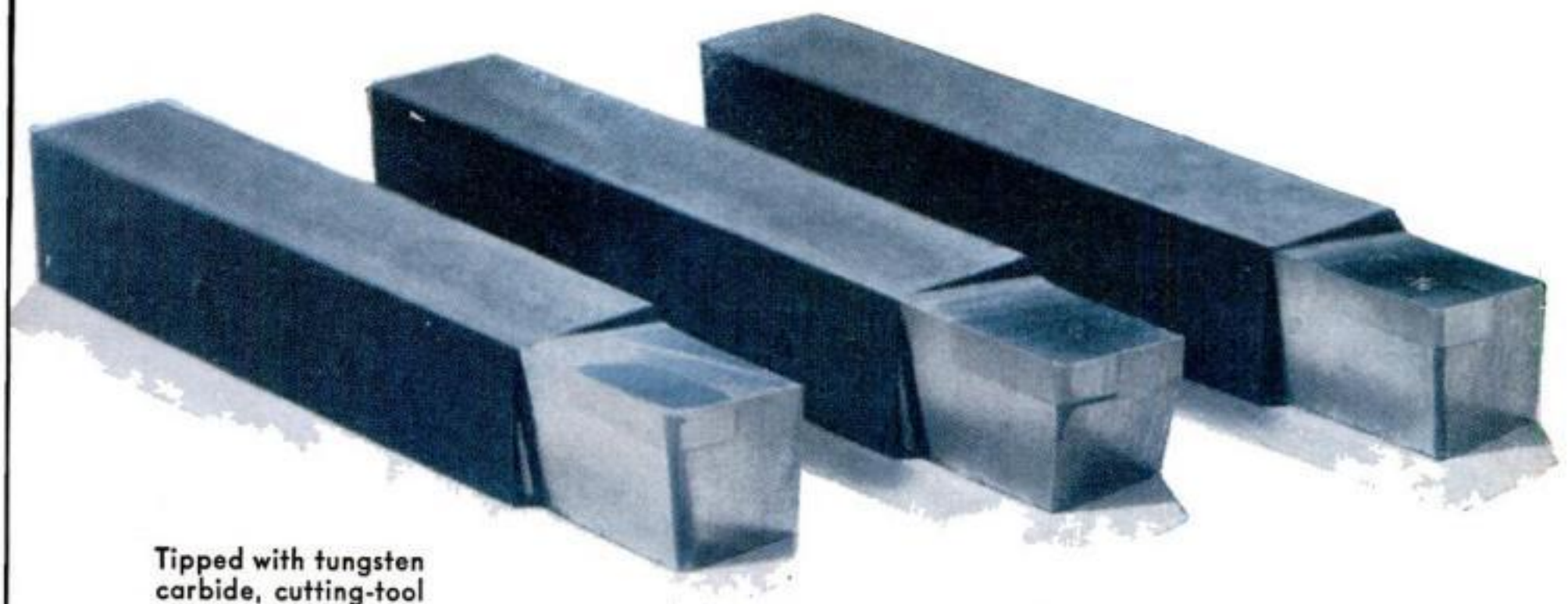
E. V. Berry, inventor of the bushing "squeezer," checks the alignment of the plunger of a big, 10-ton press as the collar approaches a worn-out wrist-pin bushing from a 155-horsepower Diesel. This press shrinks a bushing of any size to a new fit by forcing it through a tapered die



Steel, melted by an oxyacetylene flame, is sprayed by compressed air to form a new, hard coating for the bronze bushing and make up for size lost in squeezing



Excess steel is ground from the coating in a water bath (right), then sheet iron, used to block off oil channels during the spraying, is stripped off. Machining inside and out for size is the final step



Tipped with tungsten carbide, cutting-tool edges have long wear

PUTTING THE SPEED IN HIGH-SPEED TOOLS

Tungsten, Super-Hard Ingredient That Toughens Steel, Makes Cutting Edges Cut Faster for War Manufacture

By ALDEN P. ARMAGNAC

BY DISCOVERING the country's richest tungsten deposit in Valley County, Idaho, during a nation-wide hunt for strategic metals, Government experts of the Geological Survey and Bureau of Mines have gone far toward solving one of our most pressing war problems.

Domestic mines have furnished scarcely half of our 3,000-ton-a-year peacetime needs, now more than doubled. Supplies from China, once the world's principal source of tungsten, have dwindled to the vanishing point. Even though we have contracted for 4,000 tons yearly from Bolivia—practically the entire output of South America's largest producer—tungsten has had to be rationed out to industry from the emergency U. S. Government stockpile. Now it is estimated that more than 7,500 tons, ample for all essential uses, will be available this year.

Filaments of electric lamp bulbs that light your home may provide your closest acquaintance with tungsten. But high-speed tools for armament factories consume by far the major part of the supply. In some, up to 18 percent of tungsten is alloyed with steel. Others

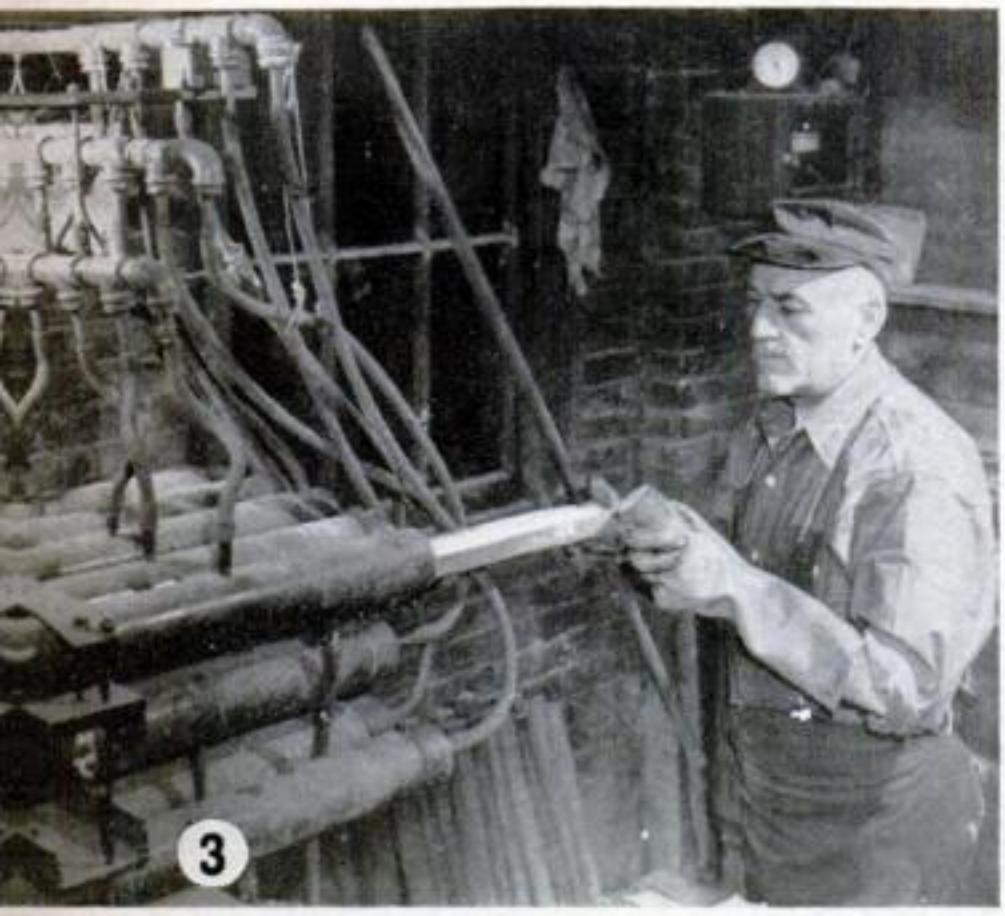
White crystals of sodium tungstate dry in the spinning basket of this centrifuge after extraction by heat and chemicals from soot-colored ore

OVER

make each pound of tungsten go farther by using an inset of super-hard tungsten carbide as a cutting edge. Tungsten carbide dies draw wire and shape artillery shells. Military uses of tungsten metal and its alloys include armor-piercing bullets, erosion-resistant liners for big guns, and armor plate.

All the way from the ore to the finished product, what happens to tungsten is demonstrated at the

Tungsten oxide, derived from the sodium tungstate, is evaporated by steam. The worker is masked against fumes and dust

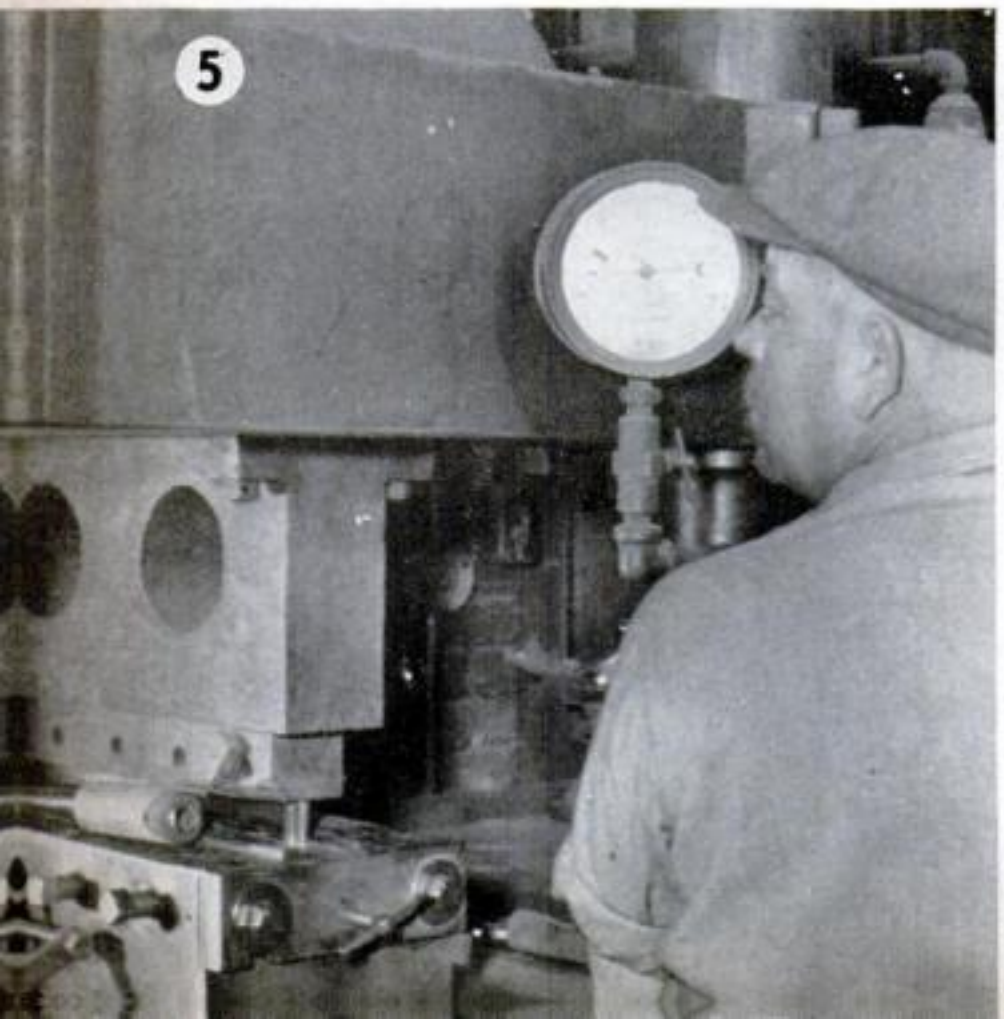


Tungsten oxide "boats" are passed through reducing tubes where hydrogen gas currents remove oxygen

Gray powder left after hydrogen treatment is pure tungsten metal, here molded into a future ingot

Hydraulic pressure squeezes the powdered tungsten into a bar firm enough to stand up under handling

A "powder ingot" leaves its mold and is numbered for identification with laboratory-tested samples

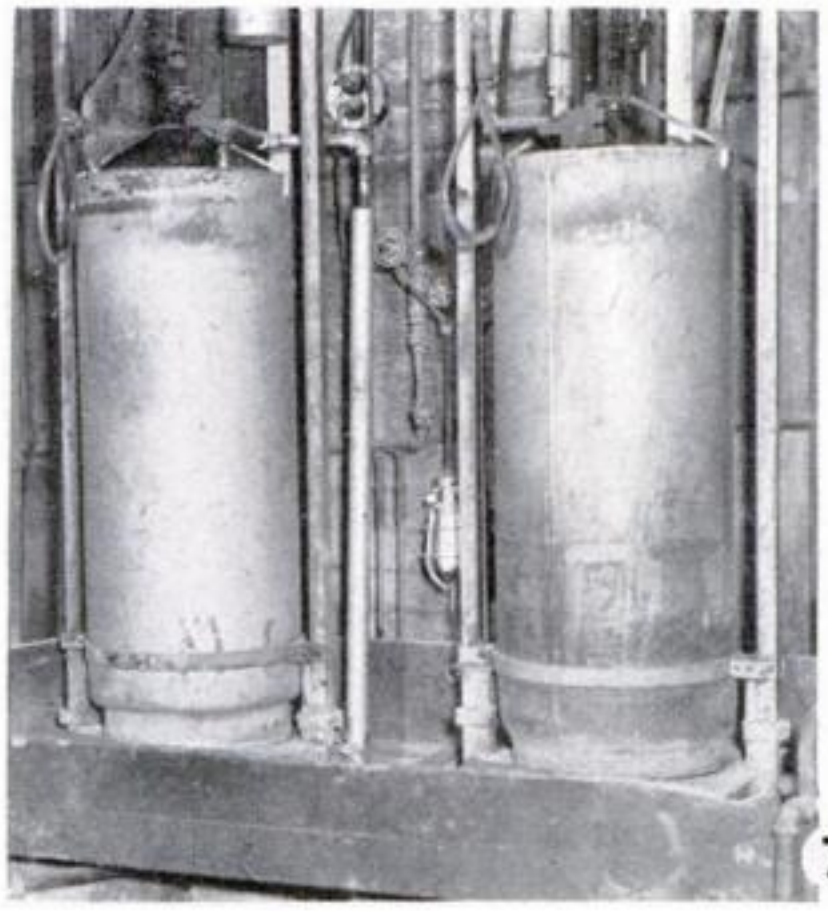


Union City, N. J., plant of the Callite Tungsten Corporation, one of the country's leading firms in the field. Its raw material is lustrous, brownish-black wolframite, one of the principal tungsten-bearing minerals.

Ground to dust, the soot-colored wolframite turns to snow-white sodium tungstate and then to canary-yellow tungsten oxide in successive chemical treatments. Next comes a large-scale version of a laboratory operation familiar to every chemistry student—reduction by hydrogen gas. "Boats" or narrow metal troughs of the oxide pass through heated tubes in a reducing furnace, where a counterflow of hydrogen removes the oxygen. What remains in the boat is pure tungsten metal in gray, powdery form.

A hydraulic press molds the powder into a solid stick, or "powder ingot," that can be handled gingerly without breaking. Fastened vertically between a pair of electrodes, the pressed powder gets a staggering 3,000-ampere jolt of electricity. Instantly the tungsten particles fuse into a solid ingot. Surrounding water dissipates enormous heat, for tungsten has the highest melting point of all metals—more than 6,000 degrees Fahrenheit.

A resulting ingot of typical size measures 15 inches long—it shrinks more than two inches during fusion—and half an inch square in cross section. The silvery bar



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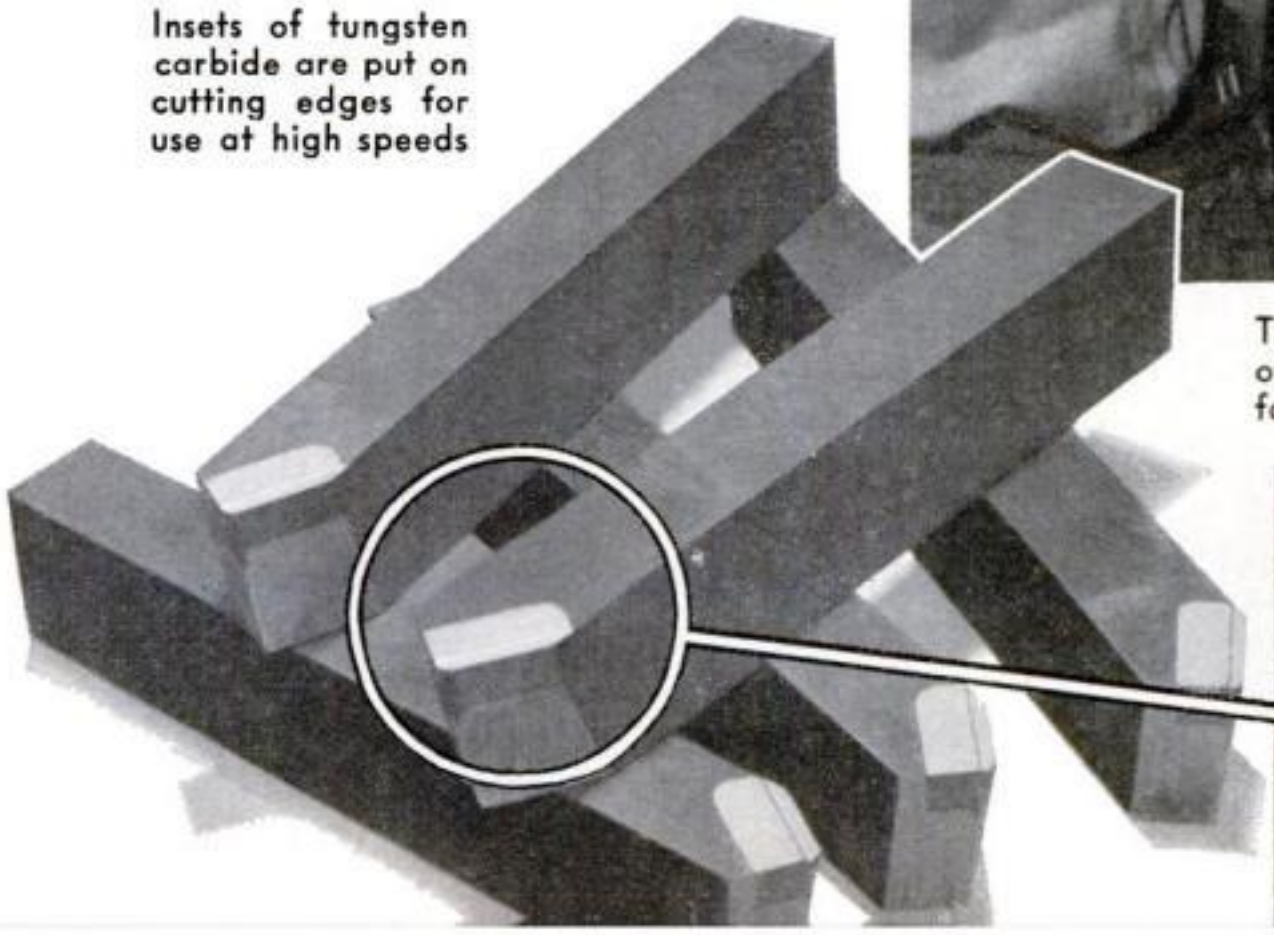
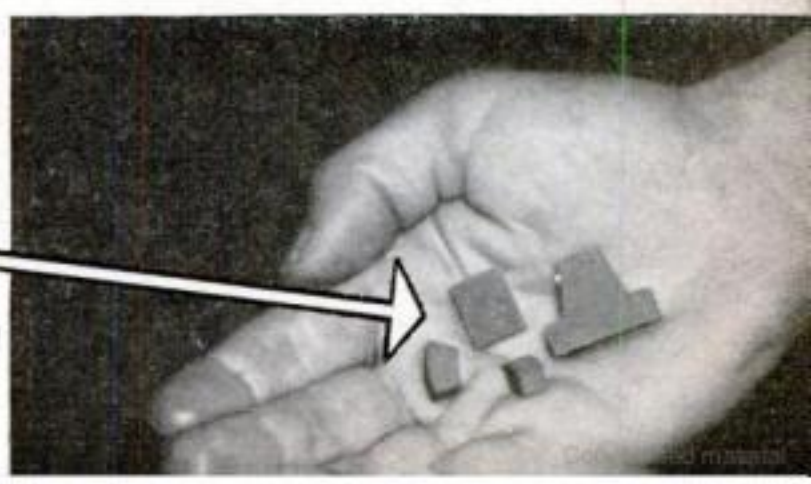
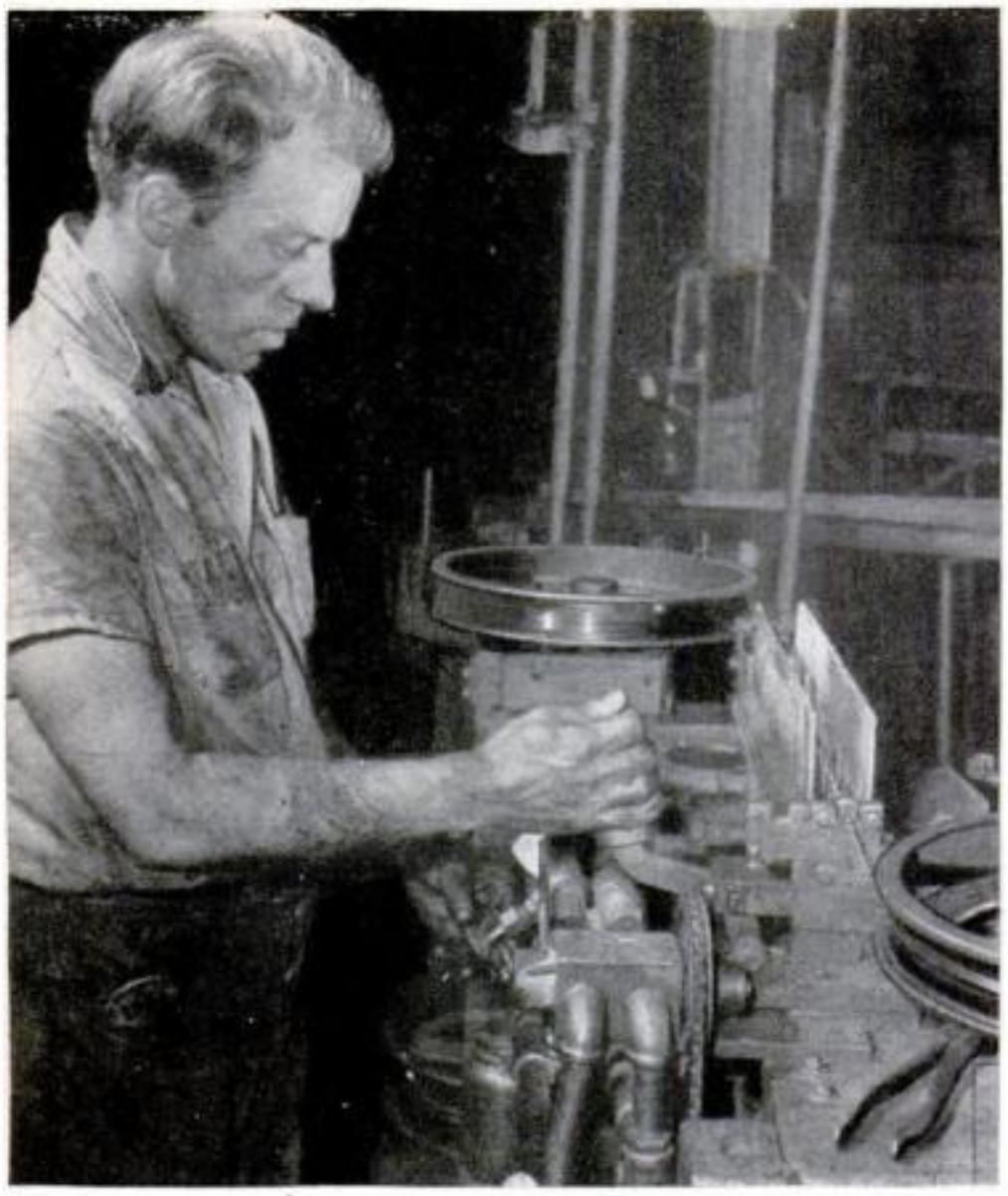
Electric jolts of 3,000 amperes fuse the powder into bars of solid, hard tungsten such as that at right. Treating vessels, shown closed above, are filled with water to dissipate the current's enormous heat

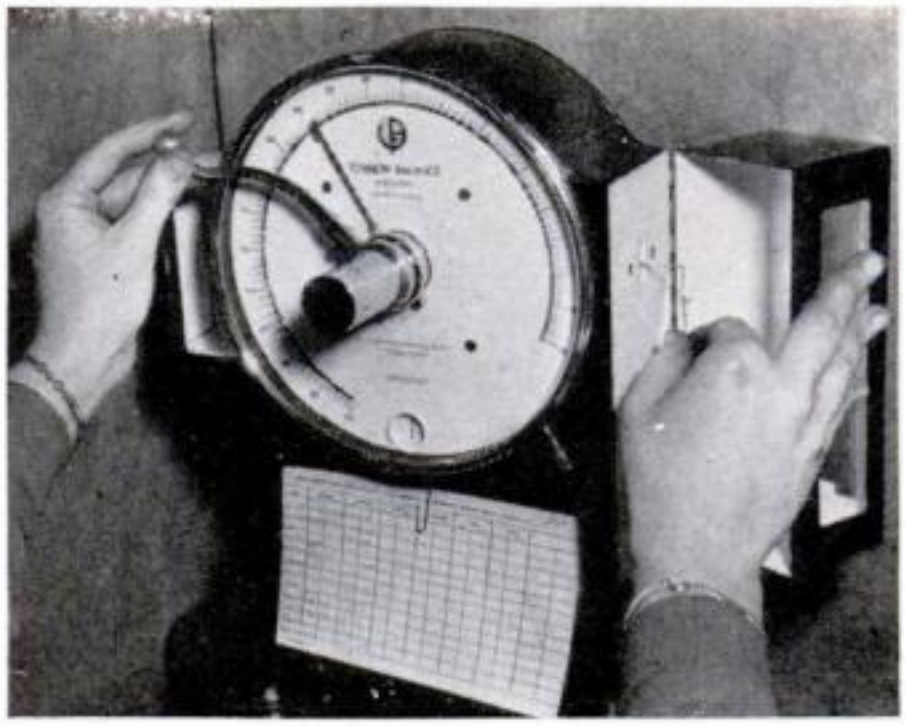
Insets of tungsten carbide are put on cutting edges for use at high speeds



Tips of tungsten carbide are made in a number of shapes for brazing onto cutting tools used for special war jobs. Several are shown below







Tungsten is an essential in the home, where it is used for filaments in electric lamps. Wire for these filaments is drawn so thin that the diameter is measured by weighing

At left, red-hot tungsten wire is passed through dies of successively smaller size until its diameter is fine enough for lamp filament—often less than 0.0004 inch

weighs more than two pounds; tungsten is nearly twice as heavy as lead.

Heat-treated and drawn through successively smaller dies, the ingot may become a filament for electric lamps, as fine as 4/10,000 of an inch in diameter. To gauge its thickness, ordinary methods are out of the question; a measured length is weighed. The average household lamp bulb contains two feet of tungsten wire.

Sliced into thin disks, rods of tungsten make electric contact points when the pieces are brazed to rivets or screws. Tungsten plates or disks serve as the targets of X-ray tubes, from which the penetrating rays stream.

Making tungsten carbide, for cutting tools and dies, requires no ingot. Instead, a ball mill grinds together three powdered ingredients—gray tungsten metal, black carbon, and dark-gray cobalt metal. The cobalt serves as a binder for individual particles of the tungsten carbide. Preshaped to the desired form, the mixture goes into a furnace, whose heat produces the compound. Once this has been done, the tungsten carbide is in its final form, and nothing short of a diamond wheel can alter its shape.

The richest U. S. deposit has recently been found in Idaho

GLASS IS MOSTLY OXYGEN

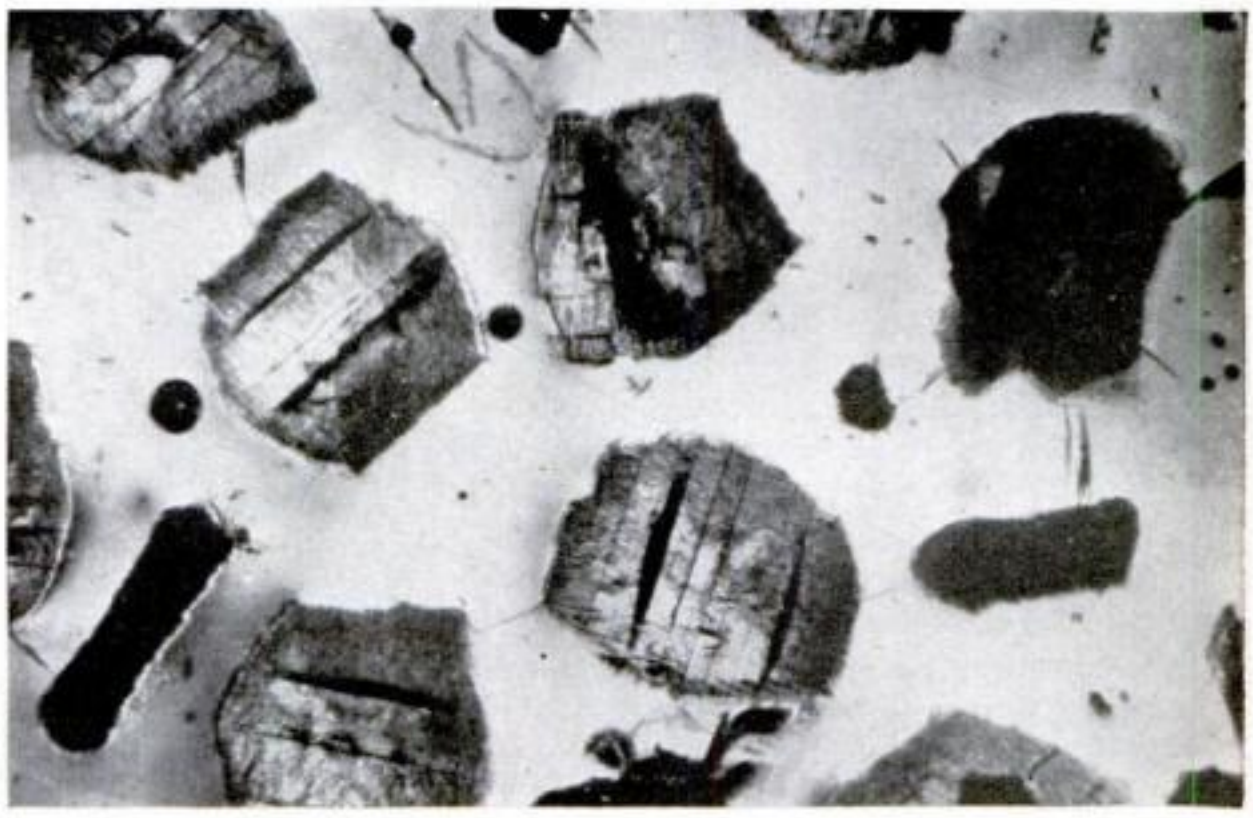
GLASS, according to a recent series of researches, consists of a cloud of oxygen atoms held together and kept from flying off into space by the binding power of a few silicon atoms. This startling new view of the nature of the material from which we make spectacle lenses, window panes, watch crystals, and telescope lenses was described recently by Dr. Alexis Pincus, of the American Optical Company.

As is well known, glass is made by fusing the oxides of calcium, sodium, and silicon, all compounds which contain oxygen. When they are melted together, 92 percent of the volume of the glass is occupied by the atoms of oxygen which they contained, 5 percent by sodium atoms, 2 percent by calcium atoms, and only 1 percent by silicon atoms.

Oxygen also contributes 95 percent of the light-bending property of glass.

Dr. Pincus looks over an atomic model of glass magnified a half billion times. The large balls represent oxygen ions, the small ones silicon. In front, left to right, closely related silicon metal, quartz crystal, and glass

Below, a diffraction pattern of soda-silica glass as revealed in an X-ray photograph. From such studies physicists have deduced completely new theories about the atomic structure of glass

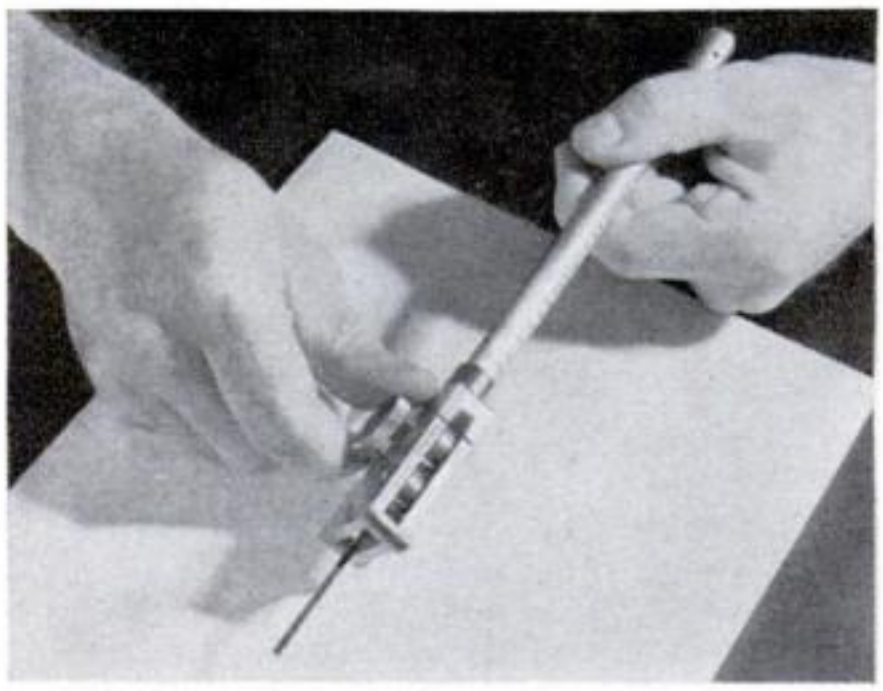


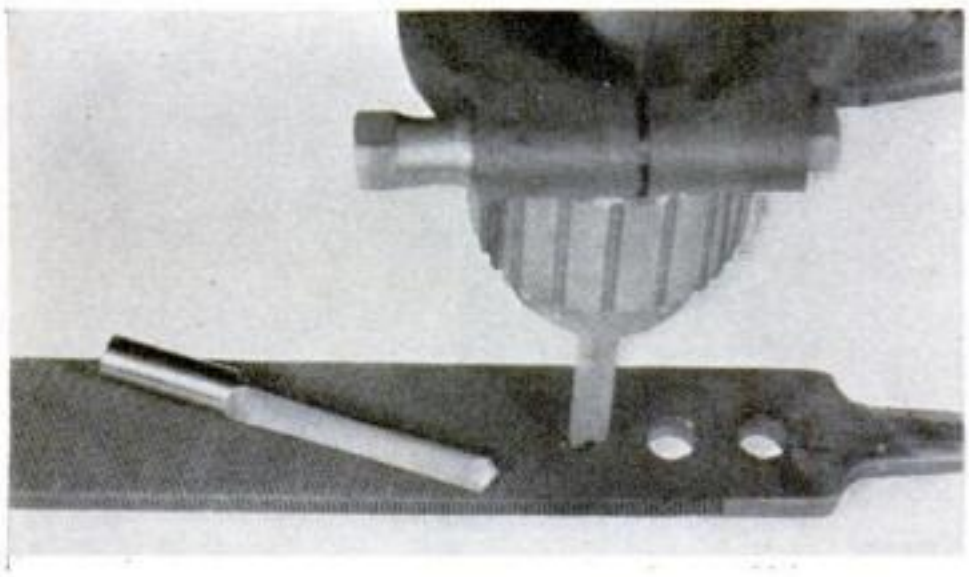
Photomicrograph of an experimental glass taken by a research scientist of the American Optical Company. This and similar pictures of the inner structure of glass are of assistance in developing new types for varied industrial and decorative use

new Tools

Held against a machine, the Vibrometer will spot vibration that might cause wear and inefficiency. It is a spring-steel reed clamped between rollers

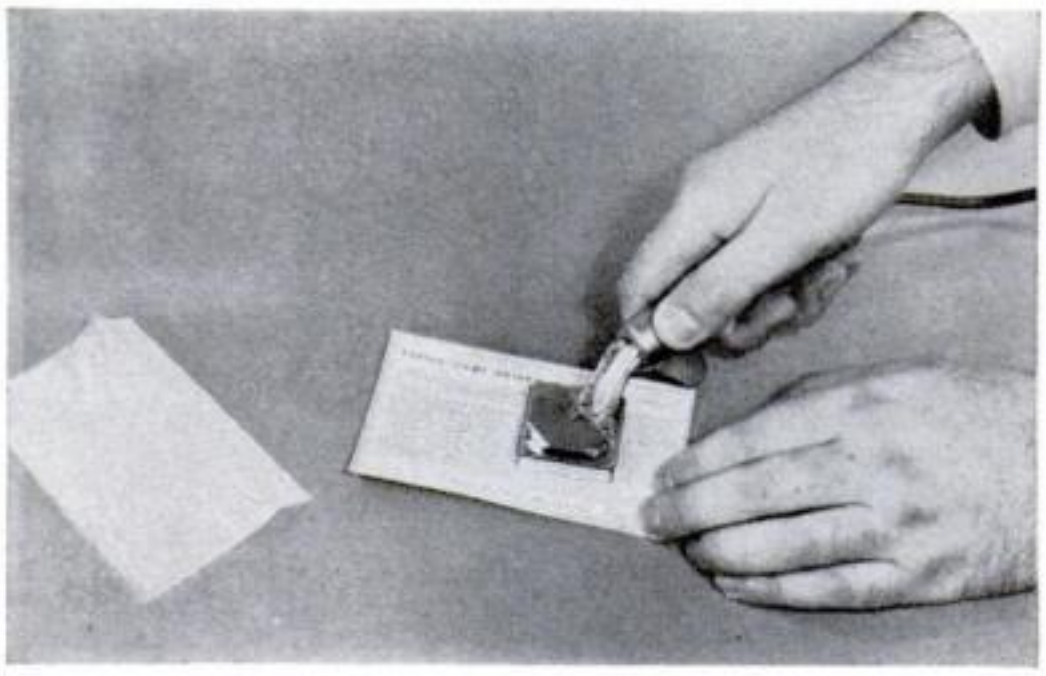
JITTERY MACHINES are now having their pulses taken by a small instrument which measures vibrations of any frequency between 500 and 20,000 per minute. Known as the "Vibrometer," this new device was developed to test the frequency of power machinery and thus enable an engineer to make a quick diagnosis of the cause of excess vibrations. The essential part of the instrument, which is only a foot long, is a thin strip of spring steel, called the reed, which is clamped between two small steel rollers. When a machine is to be tested, the head of the Vibrometer is held against a section of the outside where vibration is of particularly marked intensity, and a knob attached to one of the rollers is turned to extend or retract the reed, thus tuning it to the machine's vibration. A scale on the back of the instrument indicates the number of vibrations per minute.



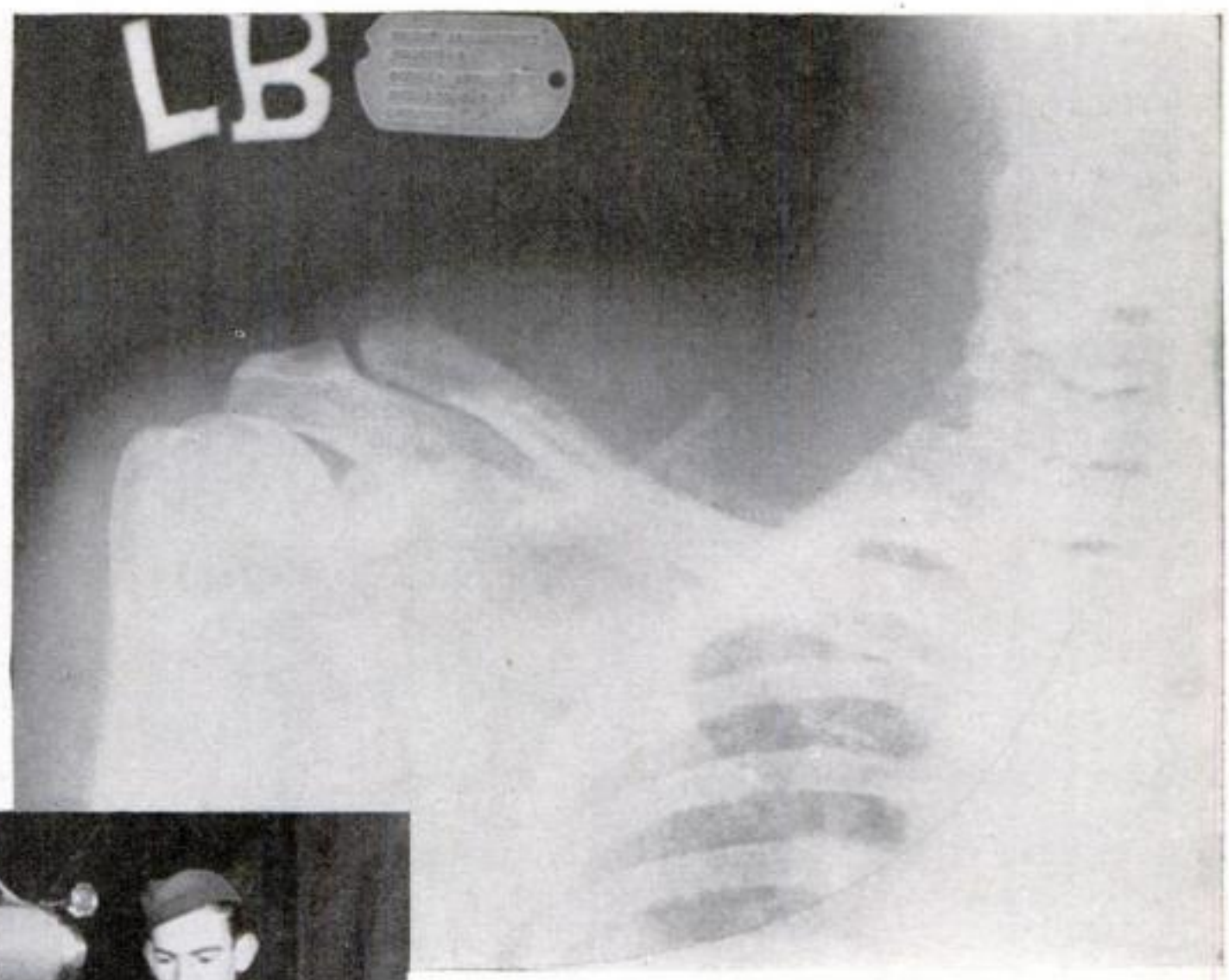


DRILLS TO CUT HARDENED STEEL without tearing it have recently been developed. They are designed to drill, ream, countersink, or counterbore the hardest manganese steel, and are said to drill even fired porcelain without chipping or breaking it. Used as salvage tools, they make it possible to drill holes in dies, tools, and similar pieces which have been hardened and cannot successfully be annealed for machining. The drills themselves can be ground on an ordinary wheel when they show signs of wear.

TRANSPARENT FILM, adhesive on one side, offers a protective surface for permanent shop records. Available in sizes to fit standard catalogue cards and file cards, it is applied with a small electric iron. Notations can be made on the surface of the film with a wax pencil and then wiped off with a dry cloth when no longer needed. According to the manufacturers, the film will not dry out, discolor, or become brittle with age. Large sheets may also be obtained and cut to size for covering posters, record sheets, and other material.

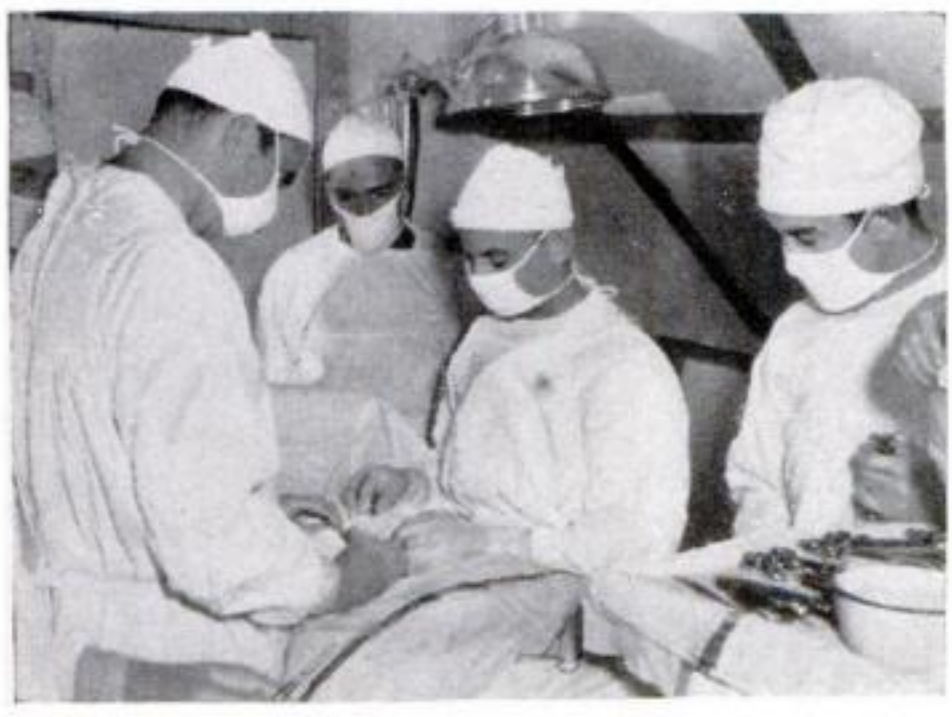


Soldiers' Identification Tags Mark X-Ray Photos



Metal identification tags that soldiers wear also make good X-ray-film markers. Placed on film, their thin-stamped letters print darker than remaining area. Tags now also show the blood type

Below, the portable X-ray machine that goes with the Army Medical Corps to its first-aid stations as close behind the firing lines as it can—which is close!



SWIFT, skilled treatment of the wounds soldiers sustain in battle is one of the Army Medical Corps' chief duties. To this end, X-ray machines, operating rooms, and laboratories, literally set up in tents near the firing line, become the emergency hospitals of Army doctors to whom time lost may mean soldiers' lives. The photographs at the left, made in tents in the field, illustrate an X-ray machine in use and a major operation being performed within such tents. Above, an actual X-ray made of a soldier's shoulder in the field shows the ingenious use of his own identification tag to record on the plate the patient's name. Of additional help to the doctor would be the symbols indicating the soldier's blood type, as now included on such tags (P.S.M. Feb. '42, p. 72). Because all lettering on the tags is stamped, the letters consist of more thinly spread-out metal which the penetrating X rays imprint on the film as darker areas, thus making them legible. Medical Corps detachments carry the wounded from the battlefield to the first-aid stations, where battalion medical officers perform the emergency work. Ambulance collecting stations are the next goal, from which the wounded are sped to base hospitals.

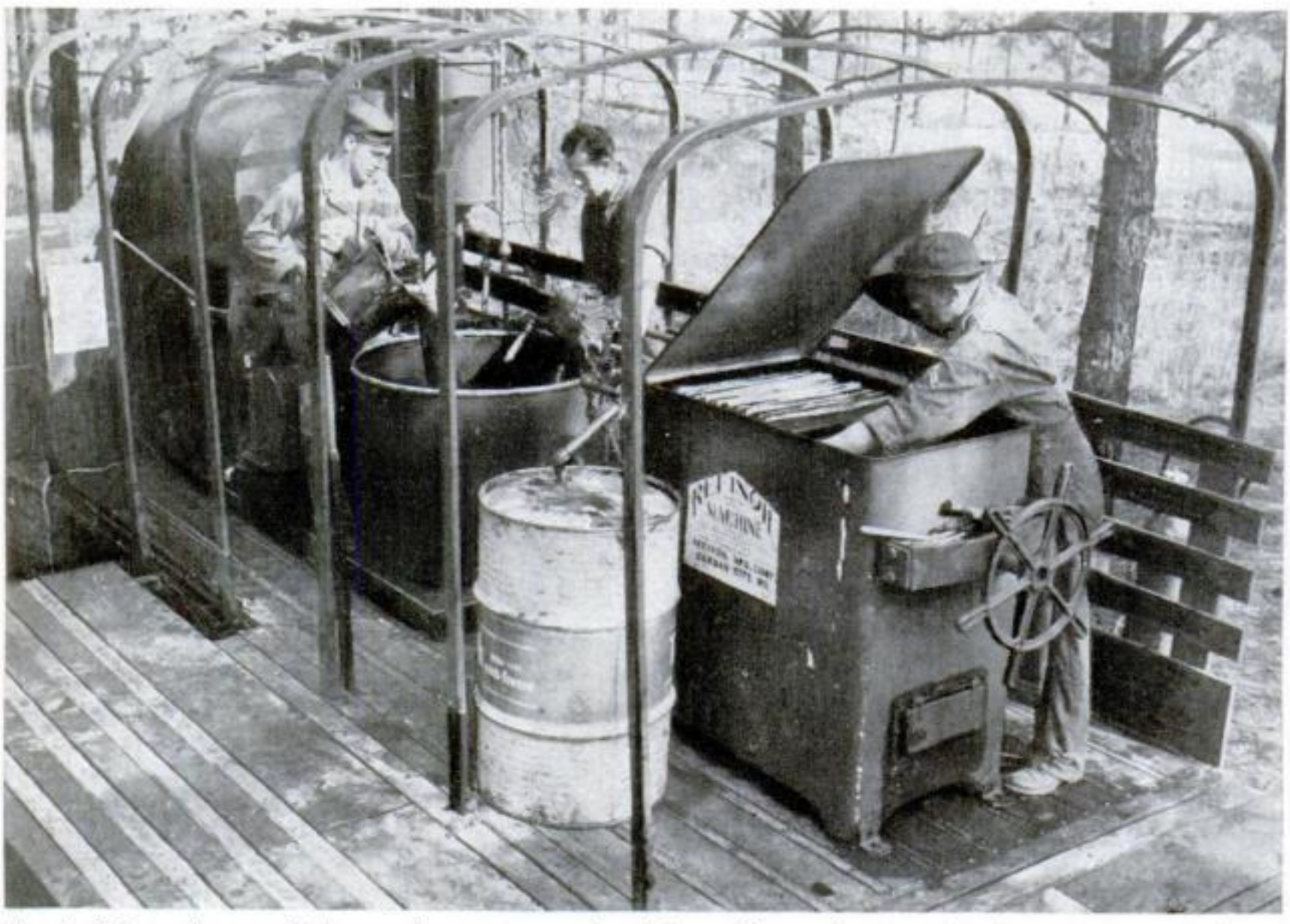
Like the portable X-ray machine, this operating room, complete with table, lights, and necessary instruments and anesthetizing apparatus, is set up in a hastily erected tent

Compact Two-Way Portable Radio Developed for Use by Army

A SMALL, lightweight transmitter-and-receiver set has been developed by the Army Signal Corps Laboratories to take the place of the more cumbersome "walkie-talkie." Known as a "transceiver," it is 13 inches long, five inches wide, and weighs about five pounds. It is equipped with a telescopic antenna which, when not in use, folds into the case. The transceiver is adjusted to a fixed wave length, and with it a soldier is able to get direct orders by listening through the receiver. To reply or give an alarm, he talks into the transmitting unit. Operation is similar to that of a French-type telephone.

Mobile Field Refinery Purifies Crankcase Oil for Re-Use

RE-REFINING used crankcase oil and transmission grease from Army motor vehicles is now done in a mobile refinery. Capable of purifying 200 gallons a day, the plant turns out a product which Army experts consider as good as the original oil. Used oil is mixed in a vat with fuller's earth, which attracts the impurities, and drawn into a retort where it is heated to vaporize and remove the impurities. After cooling, the fuller's earth and refined oil are separated by presses.



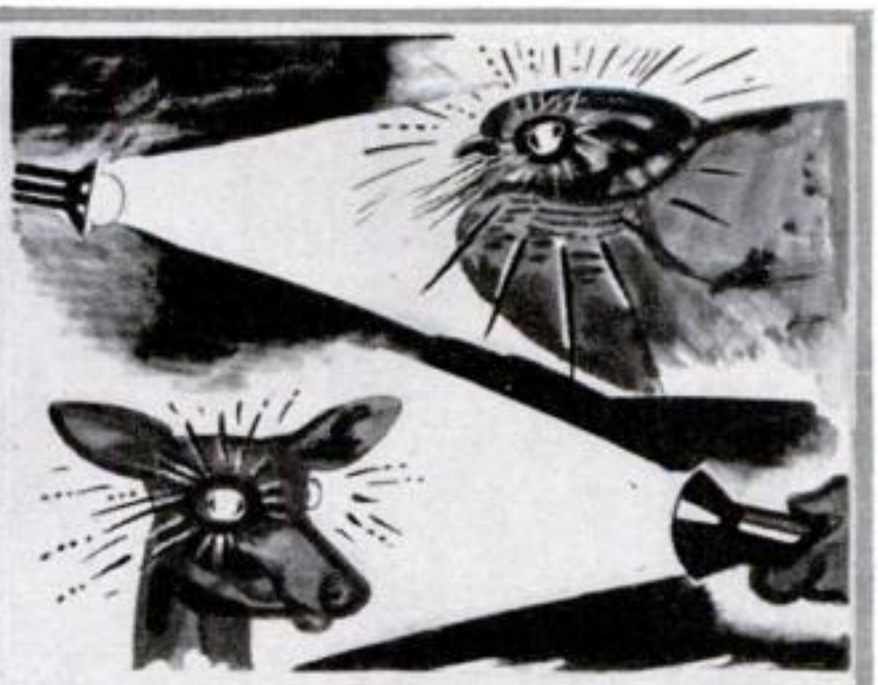
Used oil from Army-vehicle crankcases is re-refined for additional service by this traveling oil plant

Un-Natural History

BY *Gus Mager*

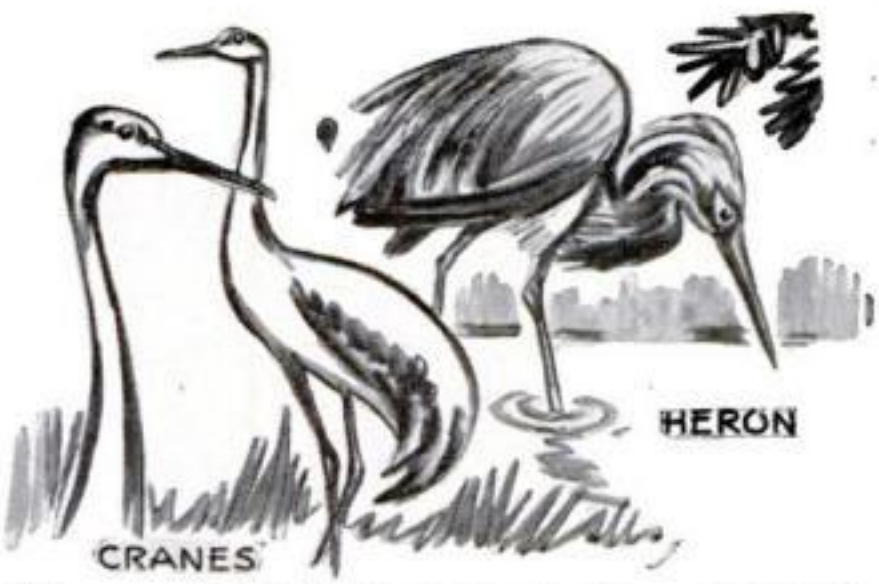
THIS LITTLE INSECT FROM INDIA HAS ITS **EYES** AND **ANTENNAE** OUT ON THE ENDS OF HANDLEBARS! PERHAPS THIS MAKES IT SEE AND FEEL BETTER!

LEAVES OF THE **TELEGRAPH PLANT**, DESMODIUM GYRANS, ESPECIALLY THE TWO SMALL ONES ON EACH SHOOT, RISE AND FALL BRISKLY AND EVEN SWEEP MORE OR LESS IN A CIRCLE! THIS STRANGE PULSATION BEGINS, GOES ON, AND ENDS OF ITS OWN ACCORD!



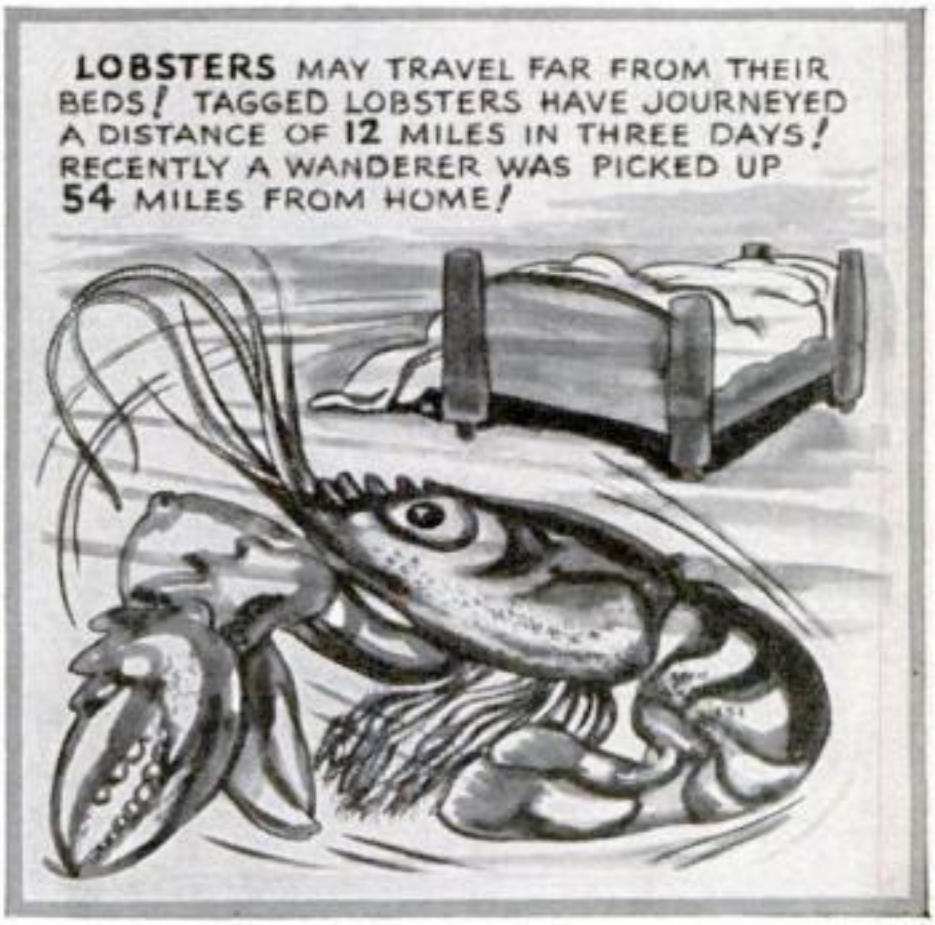
IT HAS BEEN DEMONSTRATED THAT THE EYES OF ALL **NOCTURNAL** ANIMALS AND BIRDS "SHINE" WITH REFLECTED LIGHT! THE EYES OF **DIURNAL** ANIMALS DO NOT "SHINE" AT NIGHT!

THE BROADEST EXPANSE OF WING TO BE SEEN AMONG MOTHS OF THE WORLD IS THAT OF THE GREAT **ATLAS MOTH** OF EASTERN ASIA! THIS SPECIES ATTAINS A WING SPREAD OF TEN INCHES!



ALTHOUGH COMPARATIVELY UNADORNED, **CRANES** STALK ABOUT WITH STATELY STRIDE—NOT WITH THE MINCING, SLY STEPS OF ORNAMENTAL **HERONS**! CRANES HAVE NO LOOSE PLUMAGE ON BACK OR BREAST, AS DO HERONS! THE TOPS OF THEIR HEADS ARE PRACTICALLY FEATHERLESS, WHEREAS HERONS SPORT LONG POMPADOURS!

LOBSTERS MAY TRAVEL FAR FROM THEIR BEDS! TAGGED LOBSTERS HAVE JOURNEYED A DISTANCE OF **12** MILES IN THREE DAYS! RECENTLY A WANDERER WAS PICKED UP **54** MILES FROM HOME!



FWG

FREDERIC W. GOUDY, Greatest American Type Designer, Has Left His Imprint on the World by Creating More Than 100 Beautiful Faces to Give Dignity and Simplicity to the Pages on Which Man Records His Dreams

TYPE BY GOUDY

By ANDREW R. BOONE

FUTURE generations will know Frederic W. Goudy as the man who left a greater imprint upon the recorded story of his time than any historian or craftsman living today.

At 40, this short, plump, pinkish, and puckish gentleman kept books for a Chicago realtor, and considered himself a failure. During the next 36 years, starting almost from scratch at an age when most men are permanently set in their chosen vocations, he cut 113 fonts of type, thereby creating more usable faces than did the seven greatest inventors of type and books, from Gutenberg to Garamond. Now 76, he is the dean of twentieth-century designers.

Chances are you never heard of Goudy. He is a printer's printer. As art adviser to the Monotype Corporation, his expert eye scans every drawing before it is translated into type. He is type consultant for Underwood Elliott Fisher, manufacturers of typewriters and other equipment. In his 200-year-old frame home, which overlooks a small stream splashing across a 10-acre estate at Marlboro-on-the-Hudson, 70 miles from New York City, he executes for customers from Massachusetts to California original designs, from drawing to the finished metal. His name spells authority to those who know type.

Goudy traveled 25,000 miles last year by train and airplane, preaching to printers the gospel of simplicity, beauty, legibility, and dignity. "The perfect type," he tells them, "would be completely invisible." But since invisibility would defeat its purpose, which is to carry a message, he endeavors to approach that ideal as closely as possible. You never see a flamboyant character among his designs.

"Creation" to this old master consists not in jumbling several styles and copying the

Some of Goudy's original drawings for Scripps, his 113th font of type. Note the identifying number 113 and dates that give a record of various operations

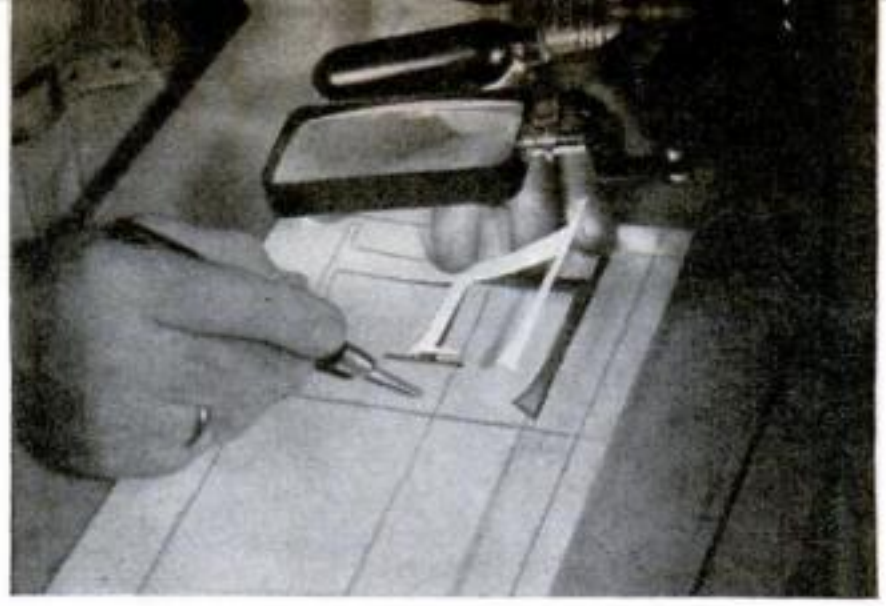
best features; rather, he draws on a well-stocked granary of knowledge kept filled by daily study, adding to tried and true forms any new impressions as they reach his eye.

Perhaps 30,000 University of California alumni have locked in their trunks or framed on study walls examples of his craftsmanship, and probably fewer than a dozen know that Goudy's hand touched their sheepskins.

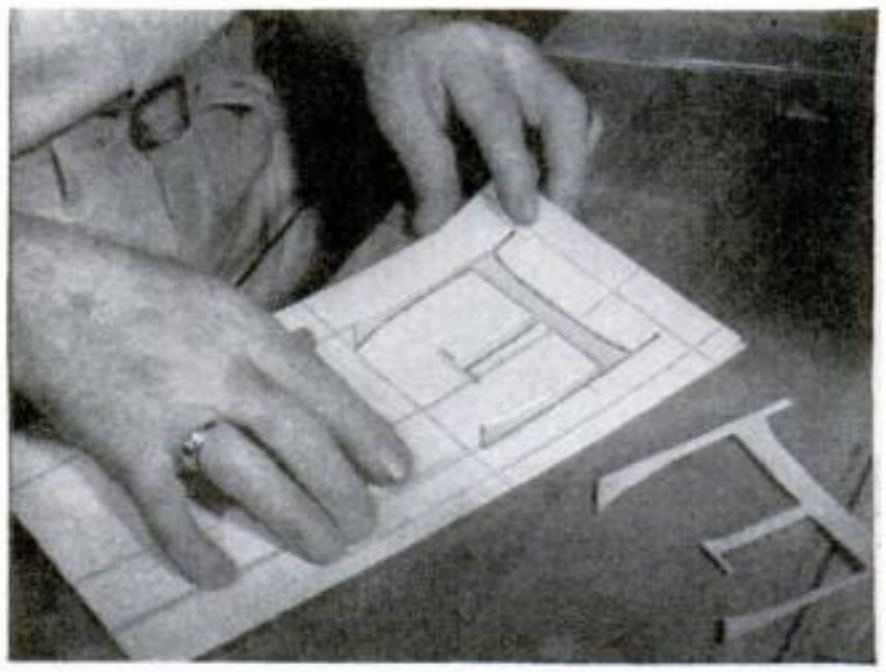
Thirty-one years ago, he visited the Louvre in Paris. While wandering among the galleries, his attention was drawn to the stone tablet pertaining to Hadrian, Roman emperor who reigned in the second century A.D. In a few minutes, caught by their classic beauty, he made a simple rubbing of three letters, P, E, and R, just as one may transfer the relief of a coin to a piece of

Birth of a new type face: Goudy first lays out five guide lines to fix the upper and lower limits of the various kinds of letters. Then, with sharp-pointed pencils, he draws the letters. Drawings are 7½ inches tall. Pinholes mark the important points in each design as a guide for the next step—transferring it onto draftsman's cardboard

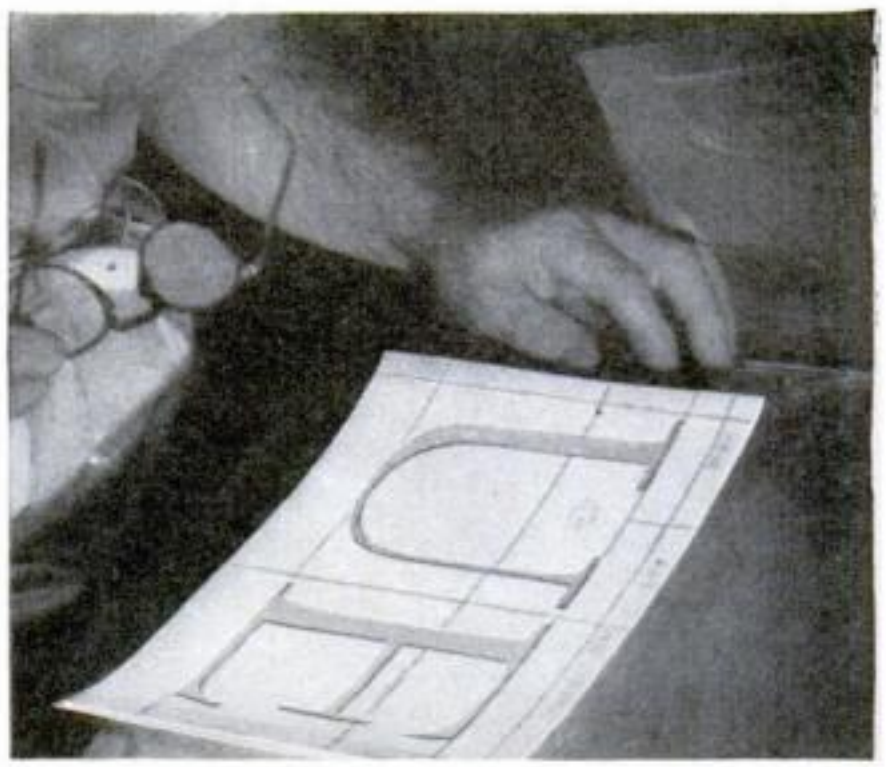
Here he is tracing the letter on Bristol board. If there are any irregularities in the design they are smoothed out carefully at this stage of the work



Peering through a magnifying lens, he cuts the letter out of the board with a sharp, thin-bladed tool, held perpendicular to produce a clean, even edge



After the cut-out letter has been removed, Goudy mounts the sheet on a piece of heavy cardboard, using ordinary water glass as cement. This makes . . .



. . . the master pattern. This is used in making the sunken working pattern, which in turn is the guide for making the brass matrix in which type is cast

thin paper by rubbing a soft pencil over it.

For seven years the rubbing lay in his desk. In 1917, when searching for a "diploma idea" he remembered those letters. Before retiring that night, he had filled out the alphabet and completed his sketches, making no change other than smoothing out the chips worn by time in the originals. Every year 4,000 California graduates receive sheepskins bearing replicas of those letters taken from the Stone of Hadrian.

Goudy calls the type Hadriano, in honor of the emperor. From a later European tour he returned with two classic forms which he calls Trajan and Forum. Trajan was copied from photographs of the Column of Trajan in Rome, while his Forum was drawn from memory.

Three great crises mark his busy and productive life. As a young man he moved to Chicago from Bloomington, Ill., where he was born March 8, 1865. He kept books several years for a real-estate firm, appraising lands and writing an occasional ad. Lettering interested him greatly, and in 1895 he submitted a set of capital letters to the Dickinson Type Foundry in Boston.

"Might these be worth five dollars?" he queried.

To his amazement, the foundry accepted his design, sending a check for $10. Jubilant over his good luck, Goudy grabbed a pencil and rapidly made a few calculations.

"Ten dollars for a half hour's work," he mused, "or $20 an hour, or $160 a day. Boy, that's fast money."

He'd made his fortune—on paper! Unhappily, however, not another sale came his way for three years.

In fact, a decade was to pass before his mounting interest in typography led him to break away from the bookkeeper's desk. Then he started a small print shop in Chicago. Scarcely a year passed before the sheriff helped him move out of the room. From Chicago he moved to Hingham, Mass., where for two years he strove valiantly to eke a living from a press. Starvation instead of the sheriff drove him out this time, and he landed in New York City to try his

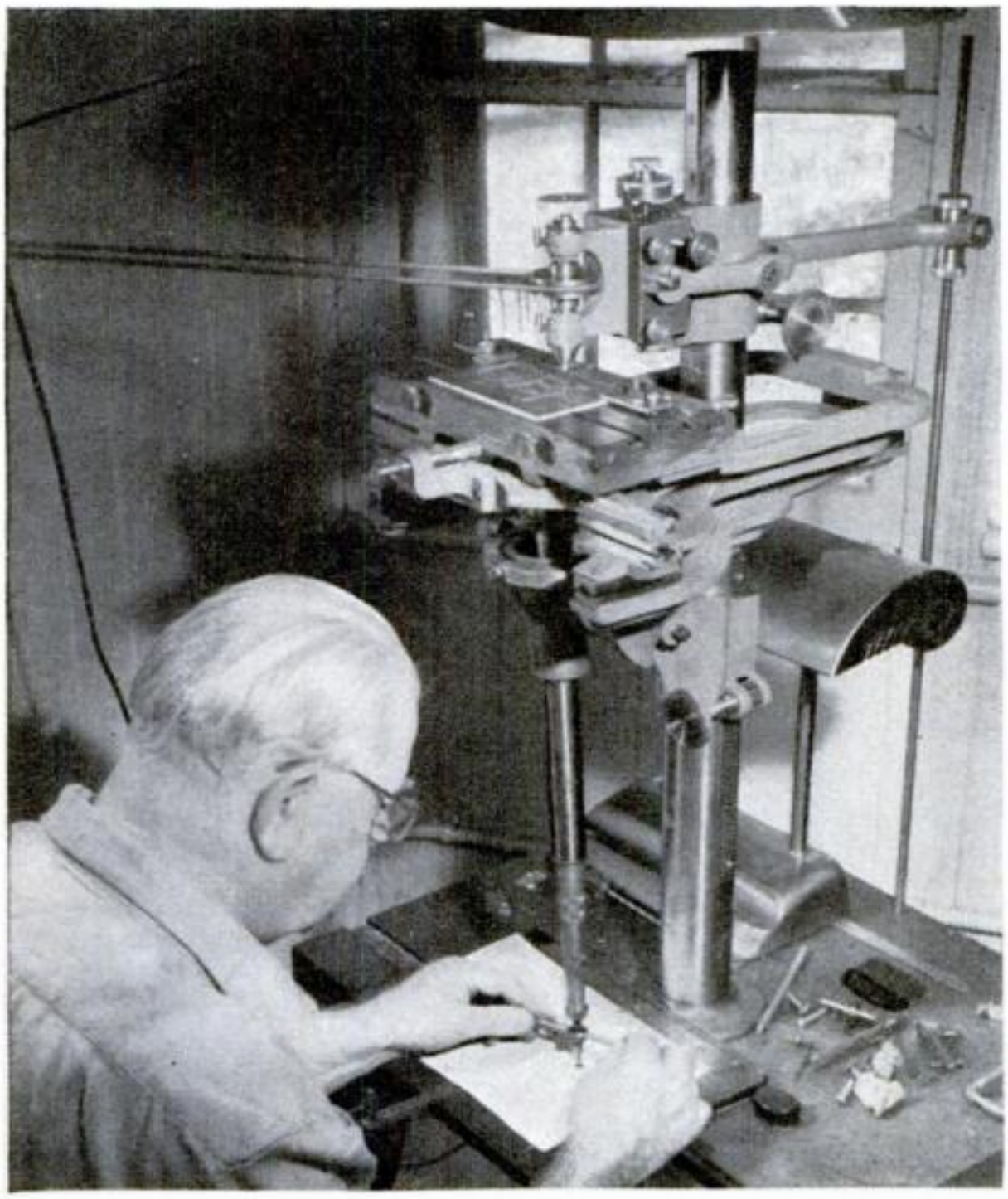
luck at the work of commercial lettering.

By 1911 his work was attracting attention of book publishers, and in that year he received his first important commission, to make type for a book by H. G. Wells. He named the design Kennerley. Shortly Kennerley reached England and Germany, and was destined to prove the most profitable of all his designs, fetching over the years more than $25,000 in sales and royalties. Kennerley was the first American type ever sold abroad.

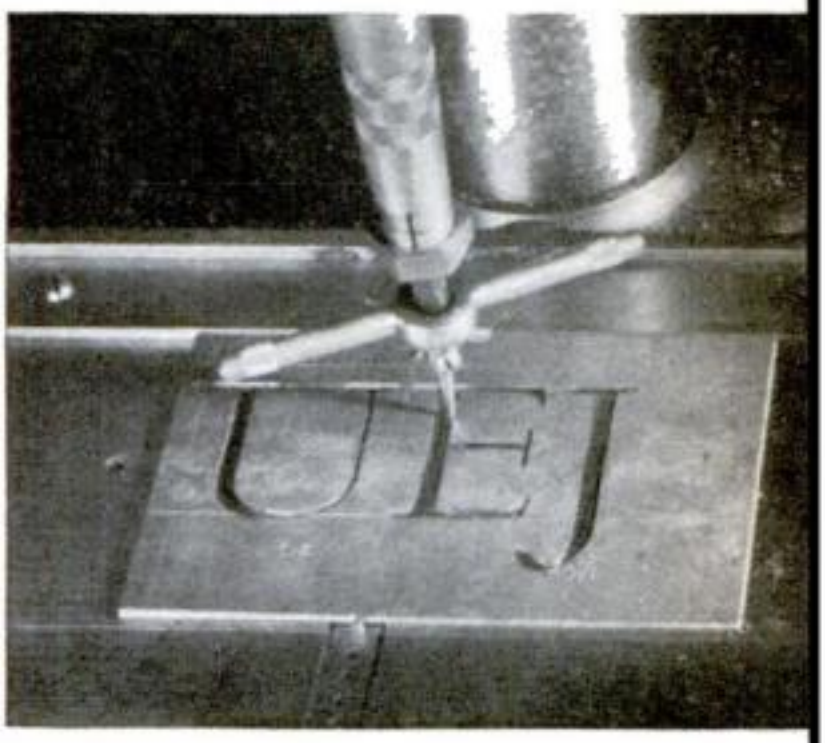
By the early twenties, he had made many drawings for type, from which the matrices were engraved by the late Robert Weibking in Chicago.

"His work," Goudy told me, "was technically satisfactory, but I do not feel that type cast by any one else carries fully into print the exact qualities of rhythm and feeling I strive for in my original drawings. No punch cutter or matrix engraver, however skillful, can do more than approximate the subtleties of another's thought and feeling."

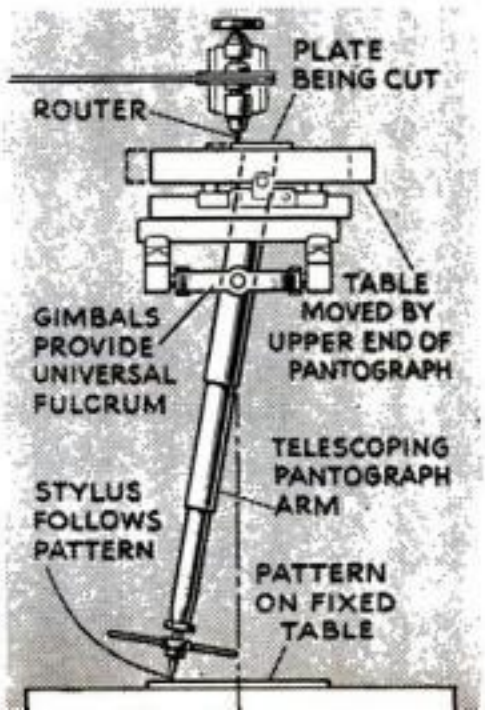
By 1921, Goudy had visions of carrying out with his own hands every detail, from drawing designs to casting the type. Strangely, fate forced him to take the final step. In 1925, he received a commission to furnish a private type for exclusive use by the Woman's Home Companion. As usual, he expected to complete the designs and

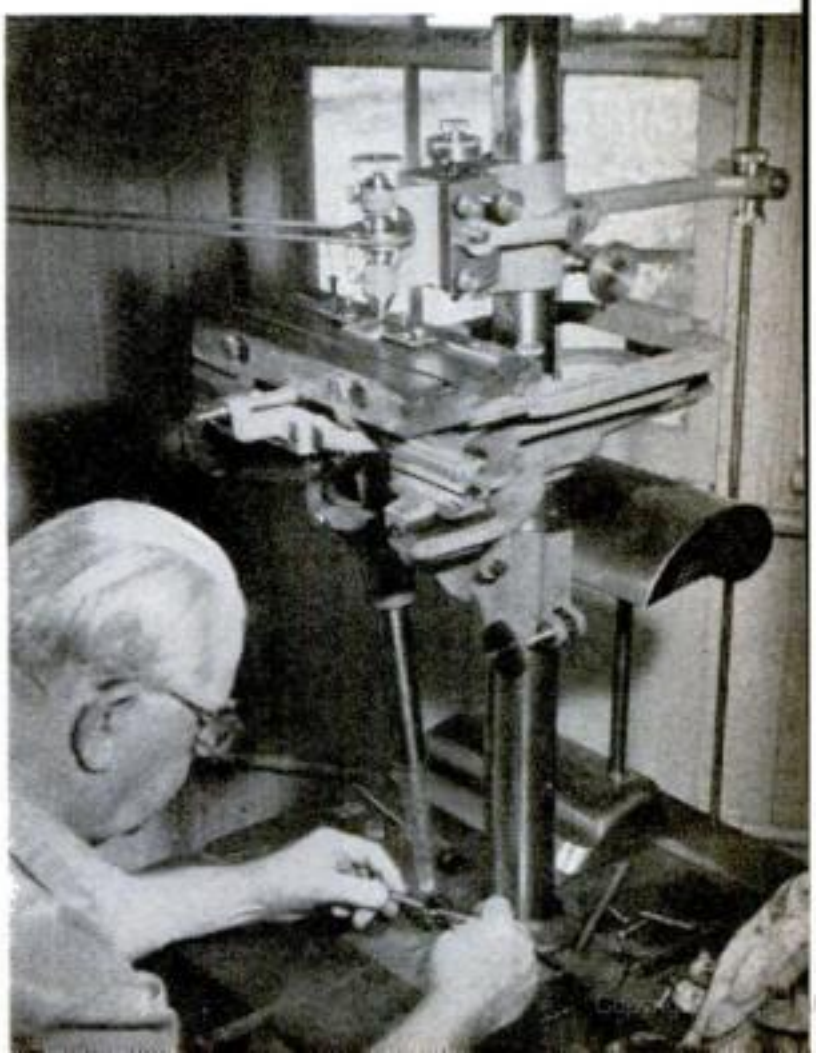


This master pattern goes into an ingenious machine called a vertical pantograph. As Goudy guides a fine tracing point by the recessed letters, a revolving cutter at the top of the device cuts the same design in reduced size on a plate of type metal. The cutter remains fixed in one place, while the metal moves under it as guided by the pantograph, reproducing the design from the master pattern



The resulting "working pattern," bearing the design of the letters reduced to 2½ inches tall, now goes into the lower part of the pantograph to serve as the guide for cutting brass matrices from which the type will be cast. The pantograph is adjusted to make these matrices the size of the type desired





turn them over to Weibking, who would cut the matrices. Goudy completed his drawings in a few weeks, and the day he was to deliver them in Chicago, word came that Weibking had died. This was his second crisis.

At 60, "with more assurance than judgment," he decided to plunge at once into the job of assembling a modest foundry. His Village Press and Letter Foundery at last was to become a true foundry. With no previous experience, Goudy began to make patterns, grind cutting tools, cast type. On delivering the job, he was able to boast authorship of every step in its conception and manufacture.

At an age when many begin to think of retiring, Goudy was just beginning to hit his stride. For 14 years he labored in his 150-year-old shop, a three-story frame structure near his residence, replacing makeshift tools with better ones, installing permanent machinery, making hundreds of drawings, master and work patterns, and type designs. Shortly before sunup on January 26, 1939, flames from some unknown source licked at the dry timbers. In a half hour, fire swept away the accumulation of a lifetime.

His seventy-fourth birthday was only six weeks away, yet as the embers cooled, Goudy was planning ways to continue. Shortly, he turned his library into a laboratory, converted a large room into a shop, and before long was busy producing matrices for the University of California's Old Style and seven other types which followed. Among them is his latest, a book design for the Scripps College Press in California—No. 113 in his record.

Already known as the father of an American school of design, Goudy has a deep conviction that we should encourage this movement, and not turn to foreign sources for ideas. Although his designs may embody the lovely script of Gutenberg, the beautiful proportions of a Caslon letter, the delicacy of Garamond or the contrasting weight of Bodoni, any or all—he doesn't believe in casting aside the historic forms—he usually insists on adapting them to up-to-date needs. And he's one of the few men since the invention of type who can do the entire job, from sketching to casting and printing.

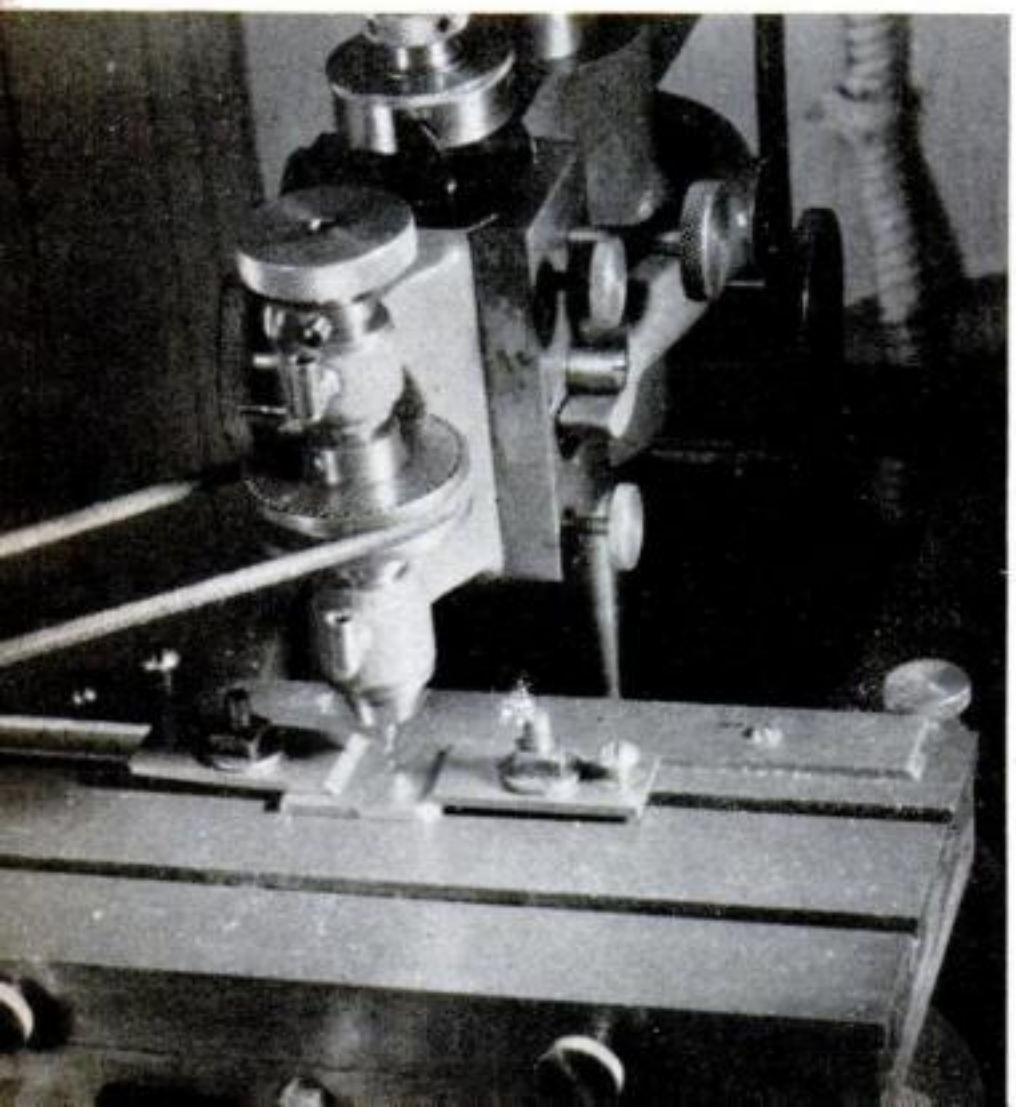
When at last, in consultation with a client, he determines the uses to which a new face will be put and the impressions upon readers desired by a publisher, the aging master goes home to Marlboro, and there bends over his sturdy drafting table.

Unlike other draftsmen, he keeps a stack of sharp-pointed pencils close at hand. Some years ago he lost the sight of his right eye. A pen may make undesired marks in the wrong places, while lead leaves its impress only when moved. He takes no unnecessary chances in making his original drawings, because mistakes take time, and he works day and night on a new design.

Goudy first lays out five guide lines which mark the limits of the letters. One fixes the tops of such letters as b, d, and h; another

THE CUTTER POINT of the vertical pantograph is made of steel that is almost as hard as diamond. In order to obtain perfectly smooth faces on the printing surface of finished type, the impression must be made within a tolerance of only .0002 inch

To keep it in perfect cutting condition, its assembly can be removed from its place on the top of the pantograph and placed in a special tool for grinding as shown below. The knurled knob gives fine adjustment in grinding as in cutting



the bottoms of j, p, q, and y. A third serves as a base for the row of letters as a whole, while two others determine thickness and variation at the tops of such letters as a, e, i, m, and n. These drawings usually stand 7½ inches tall.

You would think that a letter, satisfactory when drawn in this comparatively large size, perhaps 90 times taller than the finished type, would be well-nigh perfect when reduced. But the original sketches are inexplicably tricky at times. In fact, the type is never exactly like the sketch, and an excellent letter may produce a decidedly unsatisfactory type face. More than once Goudy has destroyed drawings when proofs from the resulting type displeased him. "I consider a type good," he told me, "when it can't be any gooder."

The completed design is traced on a large sheet of draftsman's cardboard, and the traced letters are smoothed out to remove any irregularities. From this point on to finished type, each step requires the greatest precision. Peering through a magnifying lens, he cuts each letter out of the board with a sharp, thin-bladed knife, held perpendicular to produce an even, clear edge. After removing the letters, he cements the cut-out sheet to another piece of cardboard. The depressions, outlining the letters, then become the master pattern.

With a reproducing device called a vertical pantograph he reduces the letters by two-thirds. As he follows the recessed outlines with a fine tracing point, covering the depressions with an even pressure, a revolving chisel cuts the letters in type metal.

This metal block, duplicating the original cardboard except for size, becomes the working pattern. From this pattern, Goudy, again using the vertical pantograph, engraves the recessed brass matrices in which the final type will be cast.

This is a task few men with two good eyes would dare tackle, for the letters must be cut with perfectly smooth faces, and as the tiny chisel, which cuts a line only two one-thousandths of an inch wide, revolves, the impression must be made within a tolerance of two ten-thousandths of an inch. If too shallow, a new matrix soon will be cut; if too deep, Goudy smooths down the top, rubbing off the excess metal. When you recall that he may cut letters two inches tall today and move down to letters only a twelfth of an inch tall tomorrow, you get some idea of the painstaking care required. Goudy cuts a brass matrix for each letter, figure, and decoration of each size in which the type is to be cast.

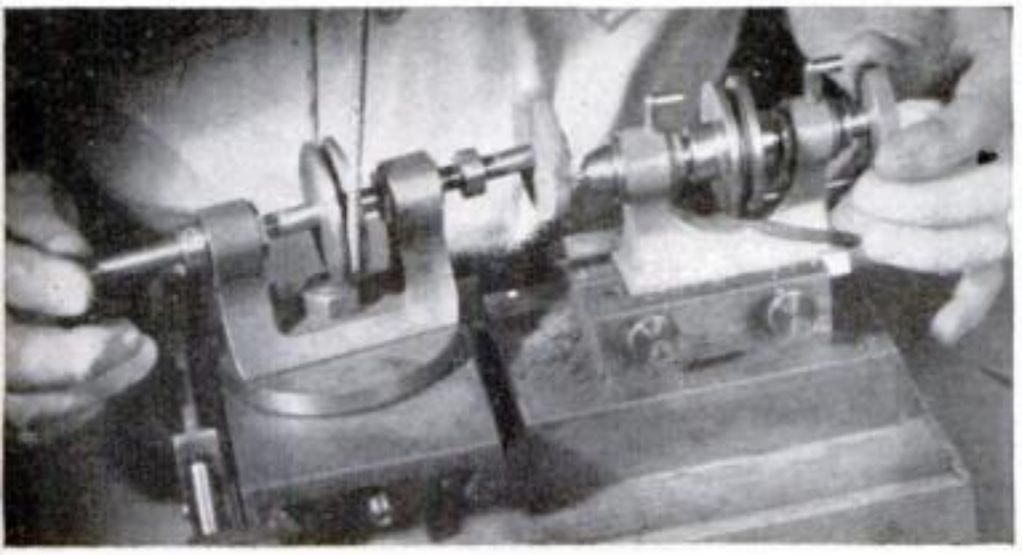
You and I can't study a column of type and describe its features. We know simply that one book or one magazine looks better than another. But why bother with a new face when many good ones are available?

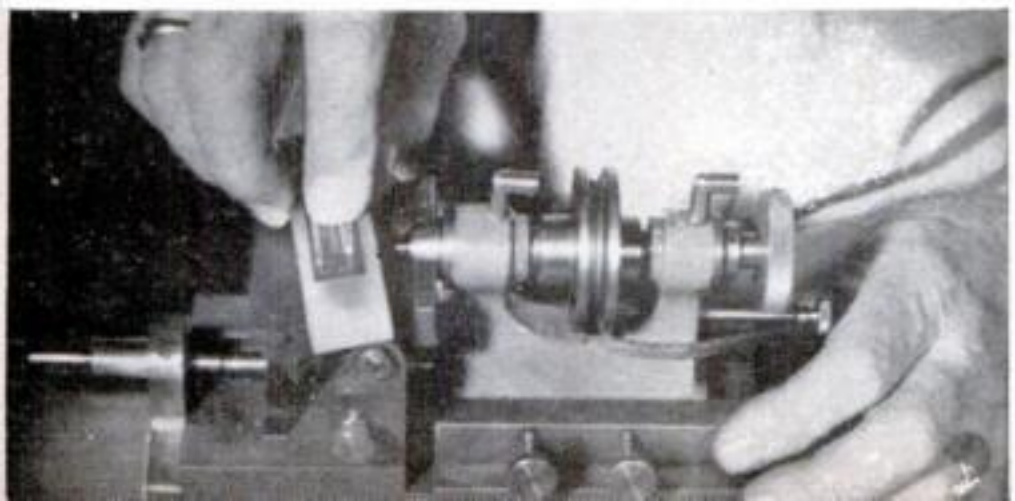
"Each face," Goudy emphasizes, "has a spirit of its own. New types express the tempo of the times.

"After all," he adds with a smile, "it is very easy. I just think of a letter and draw a line around the thought."

Further steps in finishing the cutter point. Most type designers turn their drawings over to a professional matrix engraver who performs the mechanical operation, but Goudy feels that no other man can carry the qualities of his designs into type

Examining the finished point. The great precision of Goudy's work is made all the more remarkable by the fact that he lost the sight of his right eye several years ago. In spite of this handicap, he carries out every detail from drawing to casting





Army Gets New Field Jacket That Stays Clean and Dry

AFTER a careful study of many fabrics and designs, a new field jacket of tightly woven cotton poplin has been selected as a regular part of the U. S. soldier's uniform. The jacket was developed by Major General James K. Parsons, who sought a warm, loose-fitting garment to be worn in winter, spring, and fall in place of the old wool coat or blouse, one serviceable in the armored forces as well as the others.

The jacket resembles a civilian windbreaker, is warmly lined with 10½-oz. shirting flannel, and can be closed with tabs at the collar, wrists, and waist. It is treated chemically to be spot-resistant, water-repellent, and windproof. The cloth will not soak through except in a driving rain, and unlike leather or rubber, it allows the body to breathe.

The material was developed commercially about three years ago for use in ski suits and children's snow suits.

Sheepskin Clothing Keeps Flyers Warm at High Altitudes

AVIATORS of the U. S. Army are more warmly dressed than Eskimos, thanks to scientific testing—carried on since 1929—of clothing for high-altitude flying. Rabbit, beaver, bear, wolverine, silver fox, and nutria, have been found to be either less efficient against the cold than sheepskin or not as strong.

In the Air Forces' new garment sheepskin is used with the pile facing in, and the outer shell is treated and tanned so that it is flameproof, windproof, and acidproof. The only other skin used in garments for the Air Forces is wolf. A thin strip of this fur faces the Alaskan parka hood to prevent accumulation of ice from the breath.

Sheepskin-lined clothing serves the Army's high-altitude flyers. The photos show a pilot's suit (right) and that of a mechanic

ELECTRIC FANS HAVE MANY USES

YOUR electric fan needn't wait until summer to come out of storage and start performing a round of useful daily household chores. Reminding yourself that it never does "cool" air, but circulates it, you can make living more comfortable at any time of the year by using it properly. For instance, circulating air makes for healthier surroundings. Set the fan to blow against a radiator, or along a wall toward a partly opened window, for this purpose. Laundry dries faster indoors, particularly on damp days, if the air from an oscillating fan circulates through it. On bitter-cold days, the direct blast of a fan will "defrost" window panes just as it does on your car windshield, or a low-speed breeze aimed from six feet away at your furnace draft door will help a sluggish fire.

Here's a rainy-day chore for your electric fan—drying laundry. As the fan oscillates back and forth, it blows air briskly between the pieces of clothes to speed drying

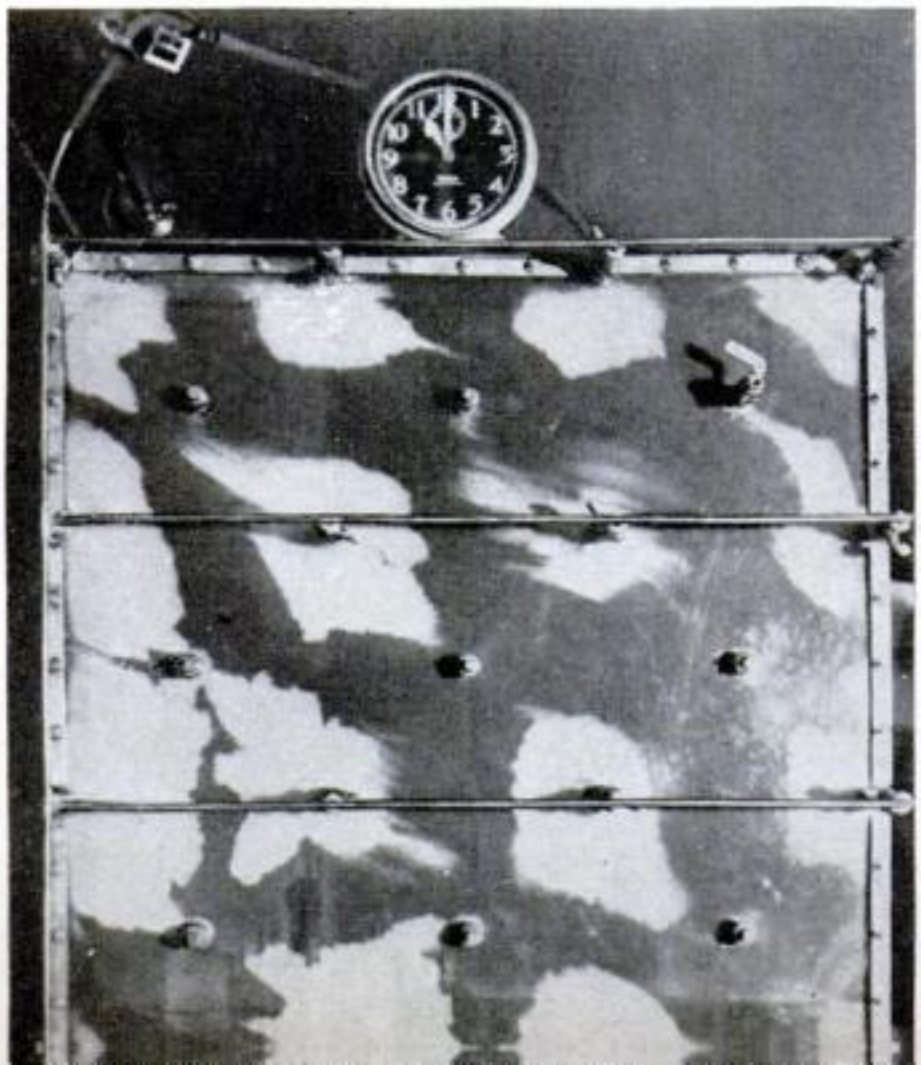
Radiator efficiency is upped, rooms kept at more even temperature, if a fan blows directly into the radiator coils, as above. At right, aimed along a wall, the fan gives healthful circulation to the air in a room

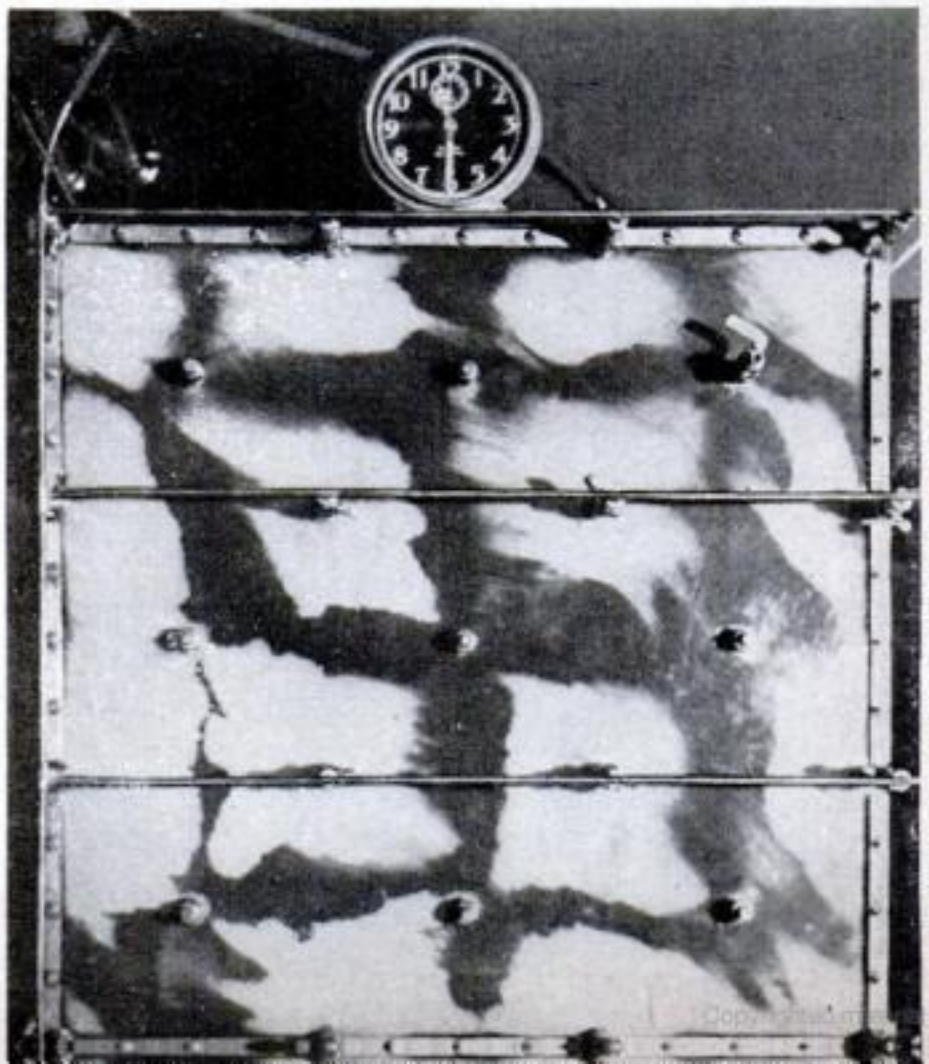
MORE

Model oil field with setup for research in water-flooding method of recovery. "Input wells" connected by horizontal tubes pump water into oil-soaked sands between sheets of transparent plastic. Water penetrates channels in sand, as seen in inset, pushing oil toward "output wells"

Below, light areas around the input wells indicate advance of water. The usual water-flooding setup in the field is four input wells around one output

As the flood progresses, watered-out areas grow in size. The job of the laboratory is to find ways of reducing the amount of oil to be left in the ground





OIL FROM OIL WELLS

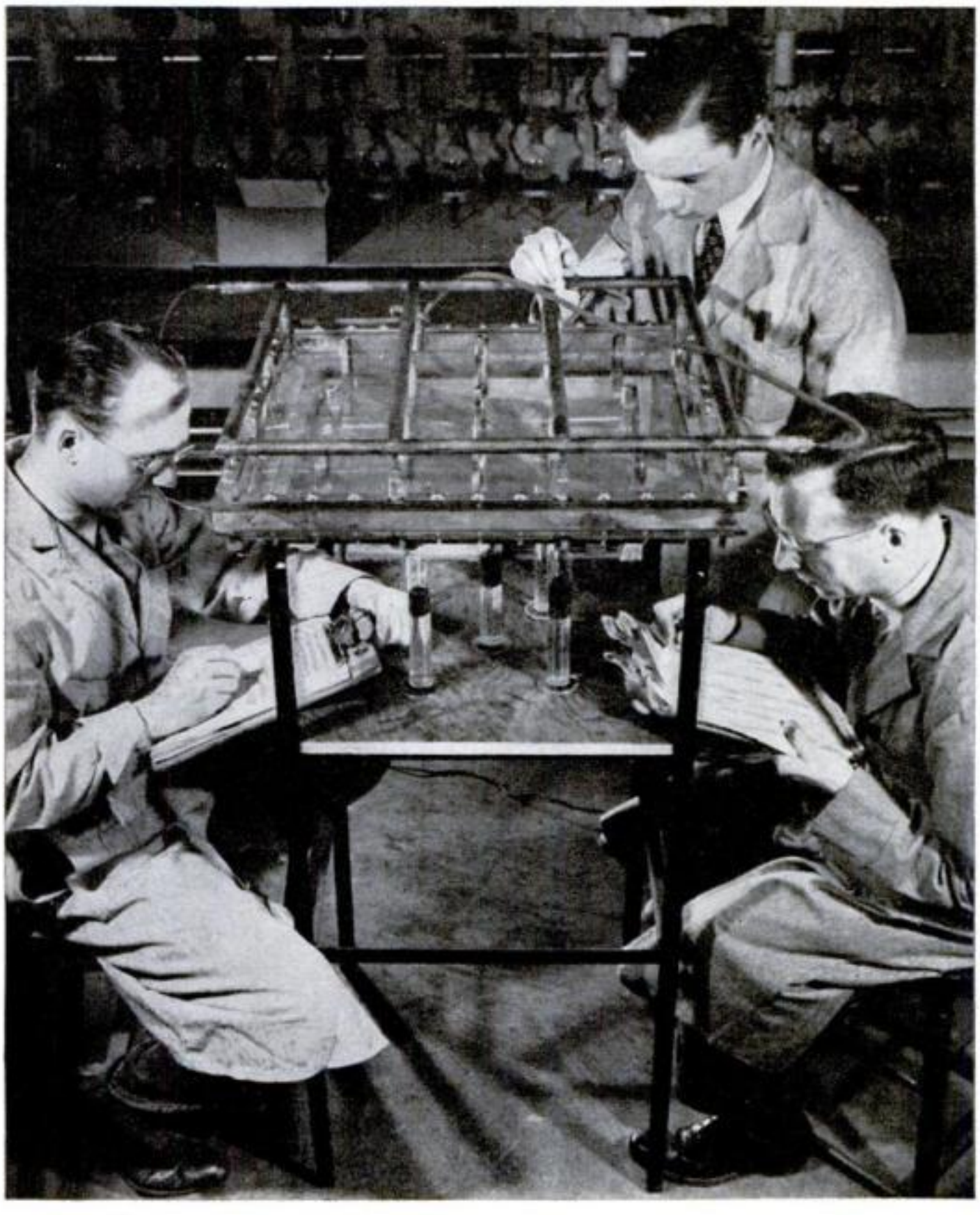
Miniature Fields and an Indoor Well in a College Laboratory Increase the Production of High-Grade Pennsylvania Petroleum

BY MEANS of models, including a miniature oil field and an indoor oil well, research scientists and students at Pennsylvania State College are working on new methods for increasing the supply of Pennsylvania oil. To insure the continued production of its high-grade product—now a war necessity—the oil industry of Pennsylvania is coöperating with the college in improving "secondary" methods of recovery.

To do this job, Dr. S. T. Yuster, in charge of water-flooding research, has invented a miniature oil field, which consists of two sheets of transparent plastic separated by sand which, when saturated with oil, represents the stratum from which oil is pumped.

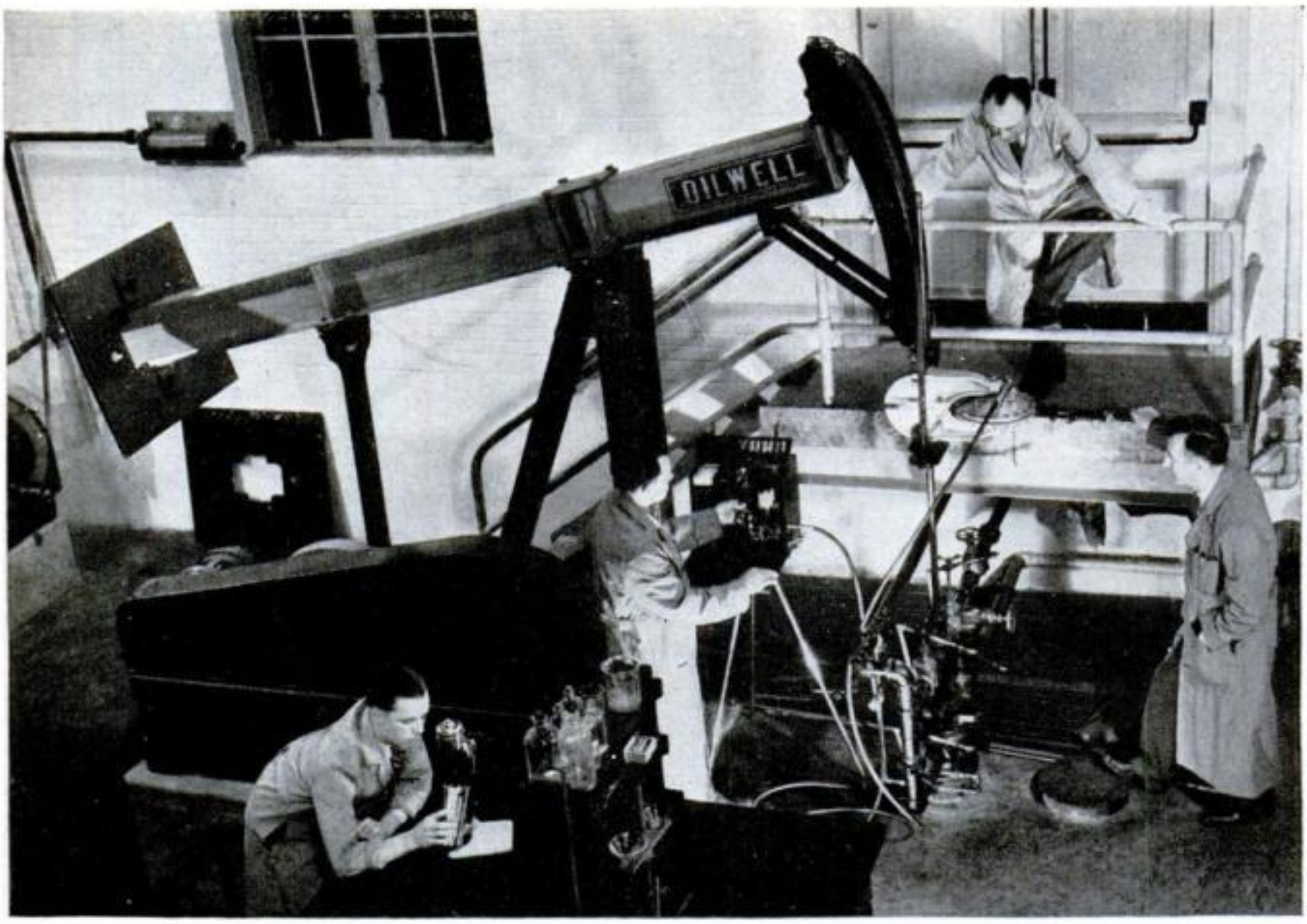
The commonest "secondary" method for the recovery of oil is by water-flooding, and the usual setup in the field is an arrangement of four input wells, down which water is pumped, to one output well, out of which the oil is forced by the water pressure. In the laboratory model, wells are represented by small brass tubes perforated in the center and covered with fine copper mesh to keep the sand from escaping with the oil. By a manifold system, water is pumped into the input wells, forcing the petroleum out of the sand and up to the surface. Under the controlled conditions of the laboratory, the most efficient water force can be accurately measured, and the rate at which oil can be produced may be determined. These facts are passed on to the oil operators throughout the state.

Three research workers take readings on the amounts of oil and water coming out of the wells. Under controlled laboratory conditions, it is possible to determine the most effective water pressure for recovery of oil

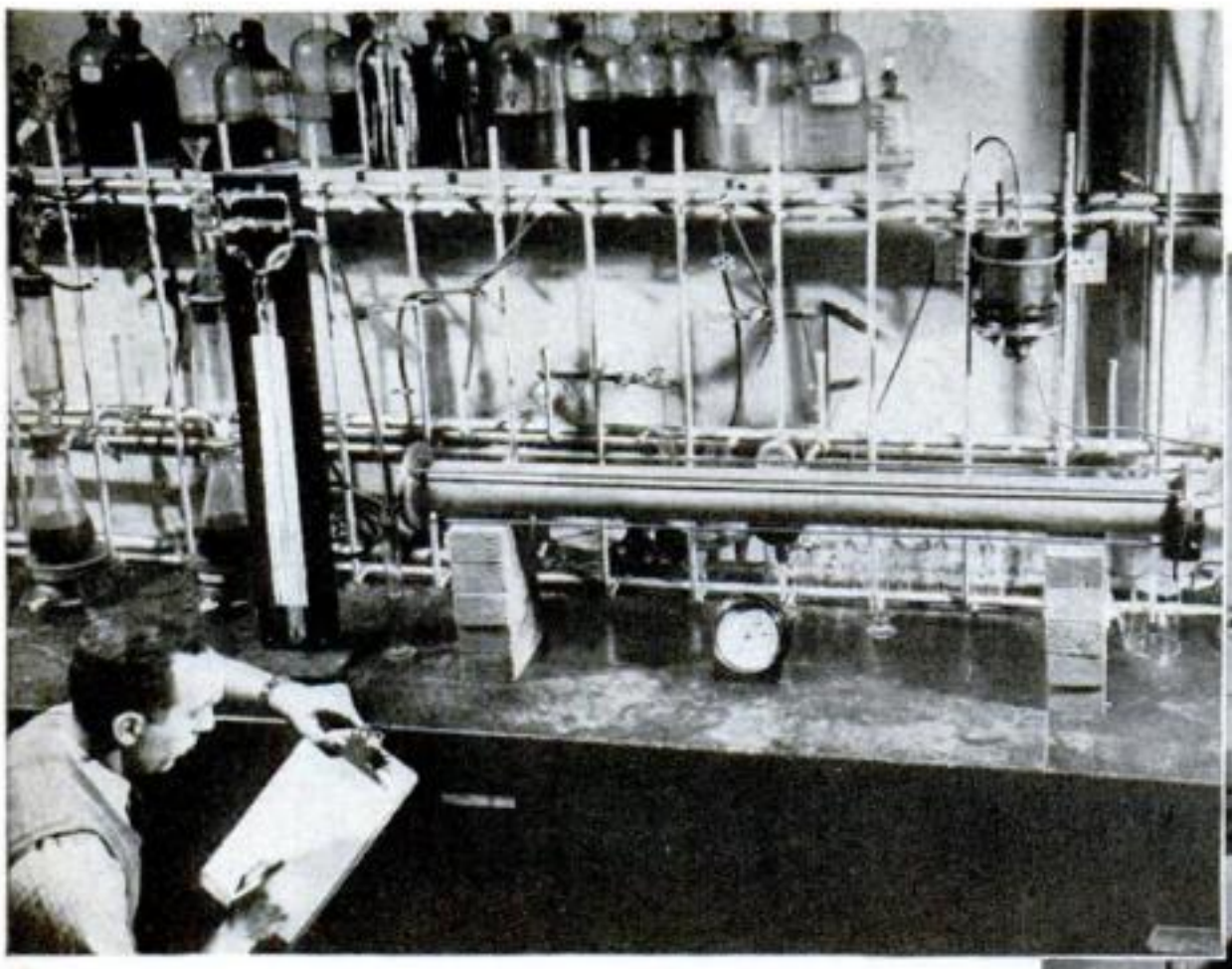


It has been found that certain chemicals pumped into an oil field in place of water do a more efficient job of extraction. While at present this method is not economically sound, it can be used in case of necessity to extract a higher pe.-centage of oil from the fields.

To answer such questions as how much oil yield to expect from a given section of strata, and how fast an oil operator should drill for maximum efficiency, the laboratory tests actual

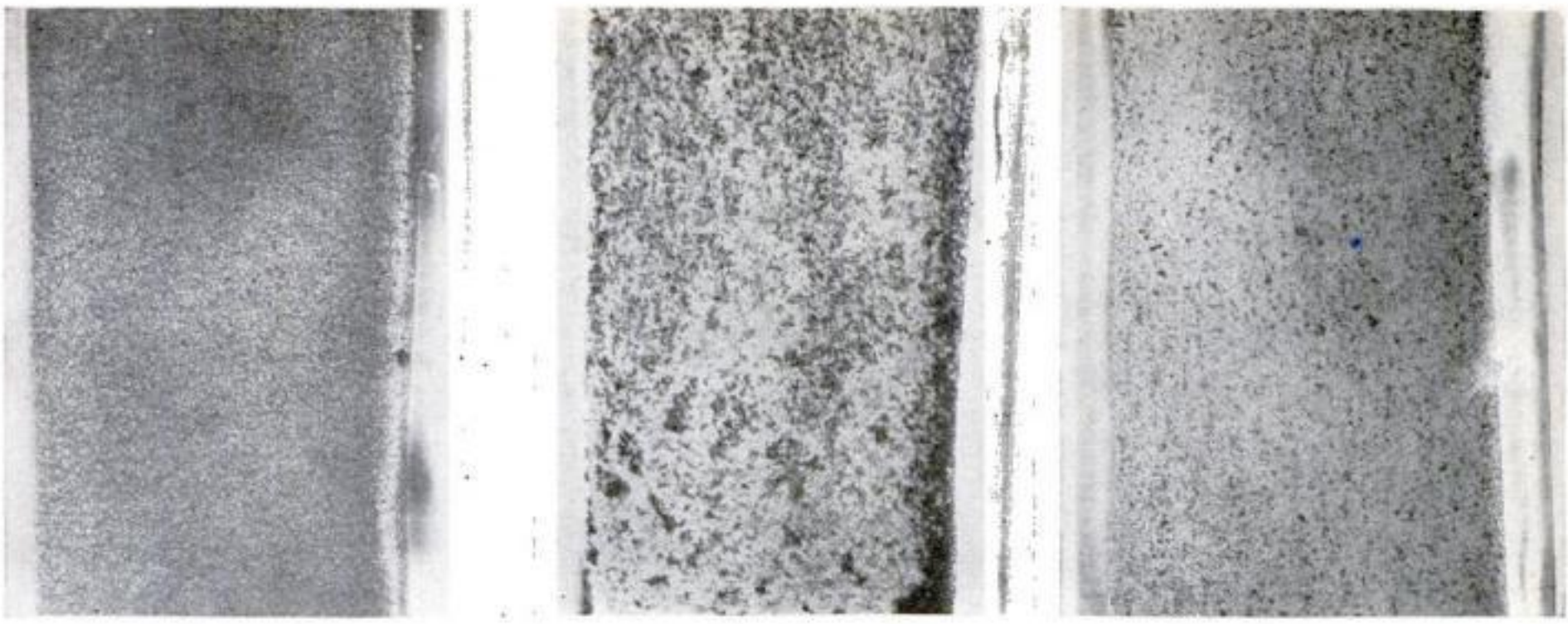


This is believed to be the only indoor experimental oil well at any American college. Its bottom, 400 feet below the surface of the ground, is cemented off from the surrounding earth and is flooded with water. The student at the instrument case is reading a dynamometer which indicates pump efficiency



Sample cores obtained in the field by horizontal drilling are tested at the laboratory for the air-drive method of removing oil. This four-foot core, saturated with 1,300 cubic centimeters of oil, gave up 450 cubic centimeters during the course of a six-months air-drive run

Below, a drill-core sample of oil-bearing sand is being put into an electric heater where its moisture will be driven off



Three views of an artificial sandstone slide that shows the water-flooding process under magnification. At left, oil fills spaces between sand grains. In center, water-flooding has reduced the amount of oil represented by dark areas. At right, better recovery was effected by use of chemicals instead of water

samples submitted from the field. A drill core is inclosed between rubber gaskets, fitted with brass nuts and a collar, and inserted in another inclosing unit. Then water is pumped in and the oil exudes from the core, which is porous though hard.

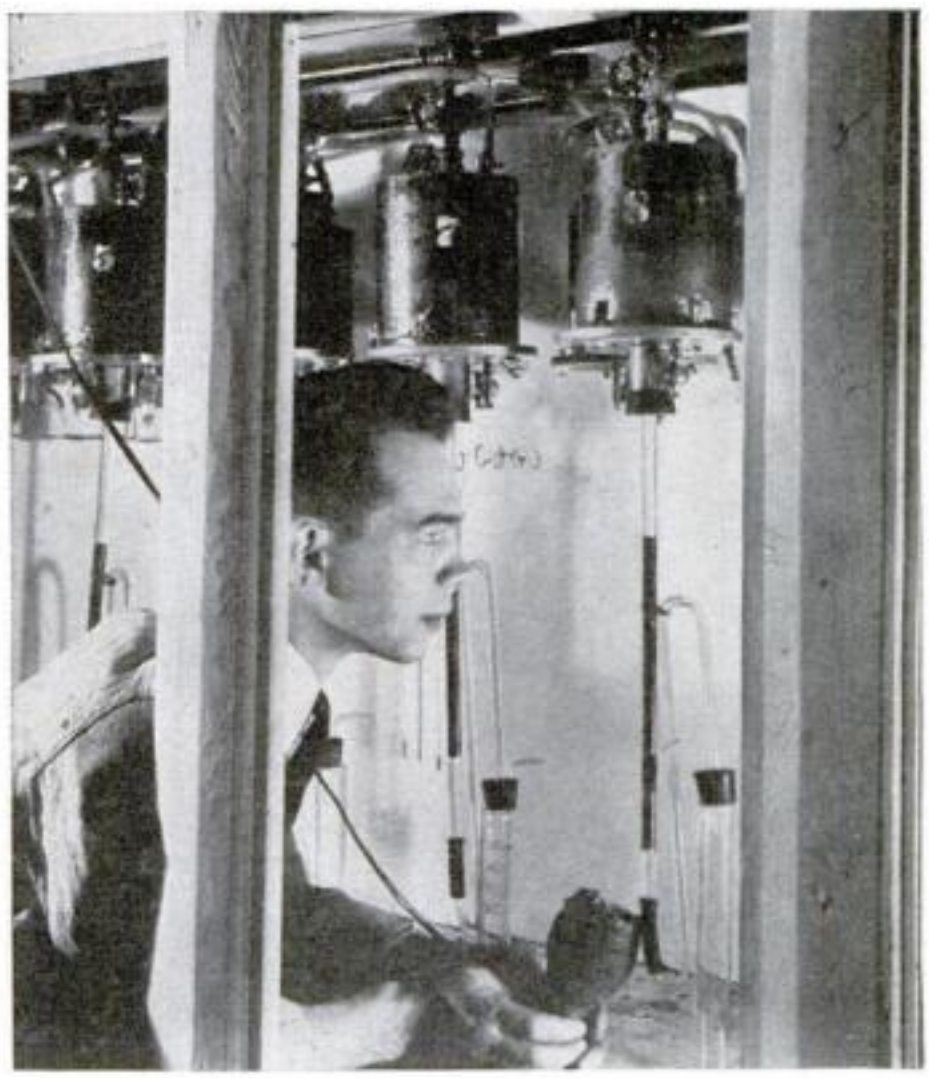
In the air-drive research laboratory long cores of oil-bearing sand obtained by horizontal drilling are tested. Whether air pressure or water pressure should be used is usually decided by the permeability (ability to conduct oil and water) of the sand. As a general rule, air pressure is applied when strata are irregular.

Another contribution the laboratory has made to the oil industry is an analysis of the amounts of explosives to be used in oil production, to replace rule-of-thumb methods.

Pennsylvania oil operators receive from the Petroleum Production Laboratory detailed production histories which are really forecasts that show them how to prolong the useful life of their holdings by squeezing out the last drop of this necessary war material.

Another piece of equipment designed in the laboratory is this receptacle for holding drill cores in testing. It consists of gaskets, brass collar, nuts

In the water-flooding test unit below, samples of strata are subjected to water pressure. As oil and water drip out, water passes over into the test tube



What Makes a Champion?

SCIENCE DISCOVERS INNER WORKINGS AS ATHLETES PERFORM

LATE on a Saturday afternoon, as shadows from a warm spring sun creep across the stadium, the loudspeaker blares out an announcement: "New world's records . . . in the hundred-yard dash, pole vault, and high jump."

From another college campus, clear across the continent, comes the news that a single swimmer has set, not one, but five new speed marks. Elsewhere other runners, weight-tossers, and javelin throwers outdo themselves with physical feats which athletes a decade ago thought never could be achieved.

Are American track and field stars developing into young supermen, or are they simply learning to coax the last ounce of strength and yard of speed out of their bodies and legs? What really makes an athlete tick?

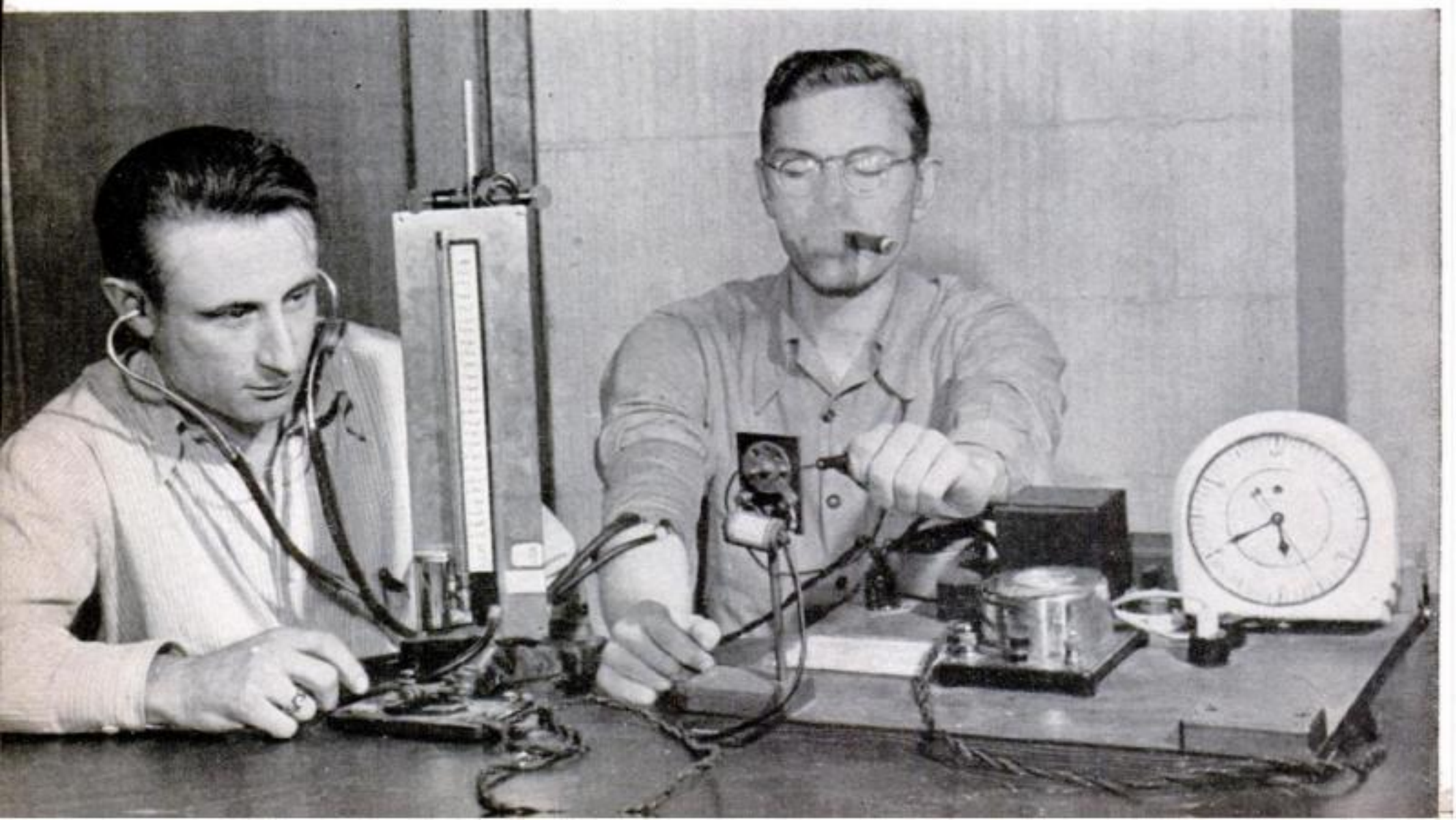
Answers to the first question are simple. We are not becoming a super-race; better performances result from improved coaching methods. As for the inner goings-on of an athlete's body, several score students at the University of California, some with athletic experience and some not, have submitted themselves to a program of research conducted by Dr. Franklin Henry, psychophysiologist of the University's Department of Physical Education for Men. Answers are being found to many puzzling questions concerning personality, mental alertness, health, and social attitudes on the one hand and physical education and athletics on the other.

The basis of the studies is a collection of intricate machines which reveal all sorts of things about the body. From Dr. Henry's workshop came recently a complex device that registers simultaneously changes in the heart rate, breathing, skin temperature, and oxygen consumption. Runners take off from special metal blocks, and an ingenious polygraph measures the pressure exerted by each foot and the time required to get away after the gun barks.

One of the unexpected results of the investigation into the dynamics of sprinting is the fact that inexperienced runners usually leave the blocks faster than even the fastest experienced sprinters. Experienced runners, however, though slower at the gun, pass the inexperienced before hitting the ten-yard mark.

In track tests which bring these conclusions, speed is measured with an electric timer which registers in hundredths of a

PUFFING ON A CIGAR, this college athlete tests his steadiness by holding a metal pencil in a small hole in an electrical receptor. Contact of the pencil with the edge of the hole notes the slightest wavering. Blood pressure and heart action are checked. It's all part of a study of why athletes tick

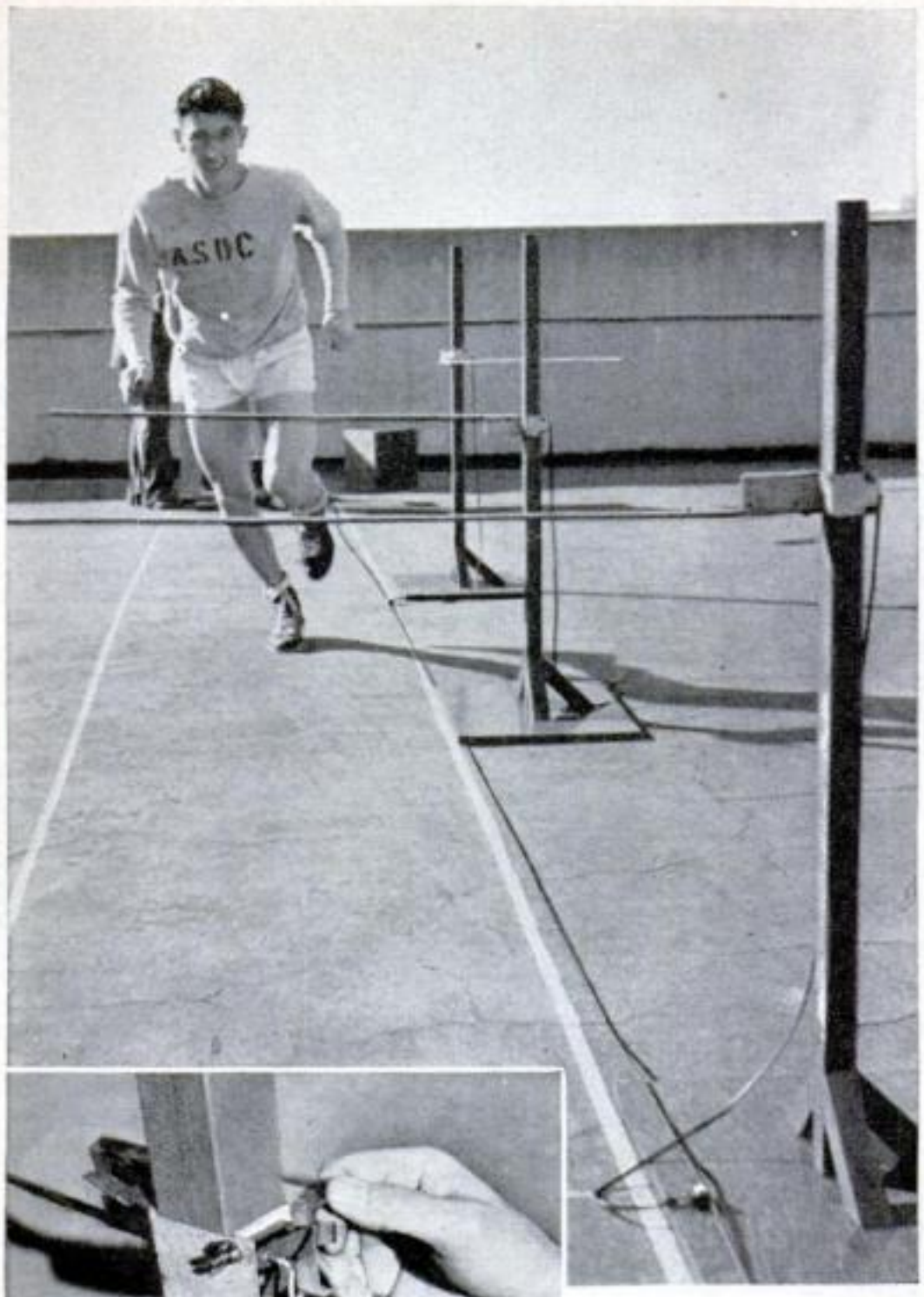


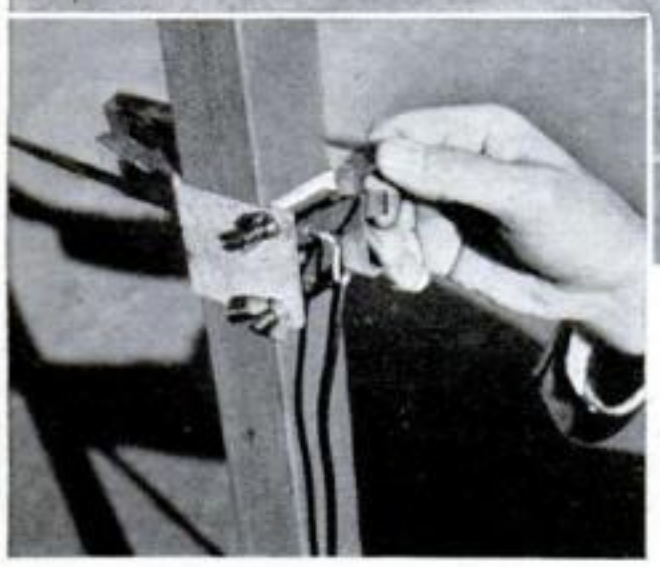
1 Off to a good start. The pressure this sprinter exerts with each foot is measured by a block connected with the ingenious apparatus on the table. The time required for the getaway after the bark of the starting gun is also measured

second as the runner presses against starting blocks connected mechanically to a moving tape and strikes light bamboo gates every five yards along the course. As each gate swings, a switch closes the electrical circuit, recording the time of impact on the tape. A cord attached to the runner operates a precision velocity recorder for the first ten yards of the race. Electrodes in the starting gun and blocks cause the mechanism to begin functioning.

Scores of runners have leaped off on this recording apparatus. How hard do they shove, do they follow through evenly, how far apart should blocks be set for most effective starts? Some, the tape shows, shove three times during the fleeting instant of departure, although they are only conscious of a single shove. One champion runner applied 68 pounds of pressure with the rear foot, 114 with the front. A hurdler put 178 pounds on the rear block, but only 111 on the front. From the time they heard the gun until both feet were clear, sprinters in a 100-yard dash got away in .403 seconds, while the same runners trying a 300-yard race as fast as they could go required .511 seconds, more than 25 per cent longer.

Fifty-four men tried both the 100 and 300-yard distances, running wide open throughout. They averaged 1.98 seconds for the first ten yards in the 100 and 2.04 in the 300. The charts show that in both of these distances the runners obeyed a definite law





2 Time is marked as the runner hits light bamboo gates at five-yard intervals, breaking the contact at left

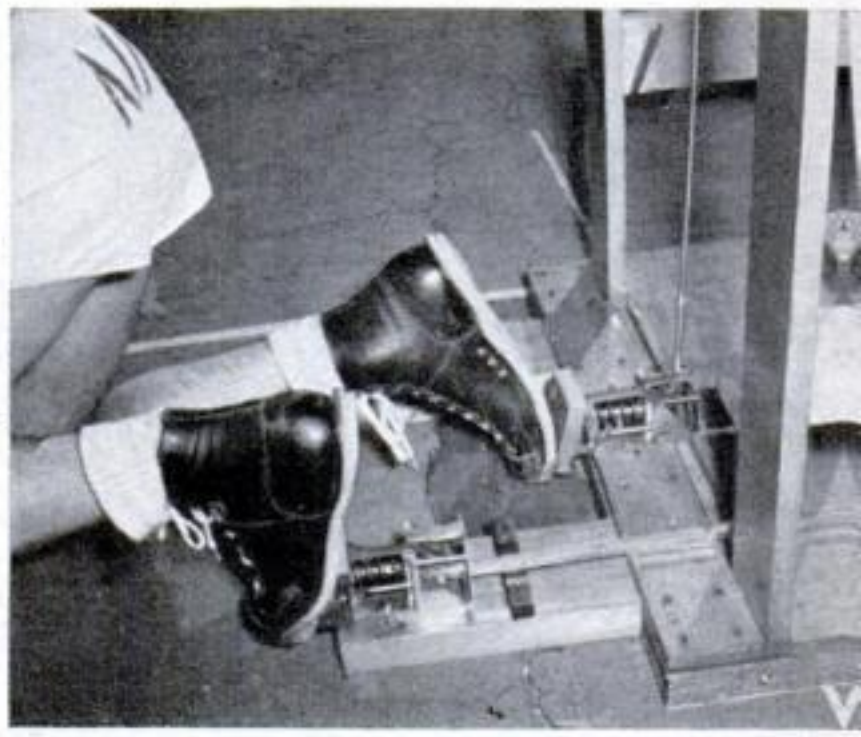
in the way their speed dropped off progressively.

Why are the fastest runners fastest? That's the question Dr. Henry hopes to solve now. Is it because they are stronger, or do they have low muscular viscosity? You can liken the muscles to lubricating oil. At peak speed, a runner works against the viscosity or drag of his muscles. If viscosity actually limits speed, as in an internal-combustion engine, coaches will seek runners with low-viscosity muscles for the dashes; while those whose muscles set up more friction will become the milers.

How important viscosity will prove to be in picking athletes has not yet been determined. A start has been made, however, with the records which show changes in speed as the runners dash past the timing stations. From these Dr. Henry is able to calculate their effective viscosity.

Another group of tests shows that the amount the heart rate speeds up during exercise reflects changes in physical fitness. To record heart beats

3 Rear view of the starting blocks, showing their mechanical connection with the recording device on the table



4 This close-up of the two metal blocks reveals how each foot applies pressure on a strong spring as the runner gets away

5 Dr. Franklin Henry, the inventor and a psychophysiologist, checks a runner's start and sprinting performance with the aid of his intricate machine. He answers many questions on why new records are made

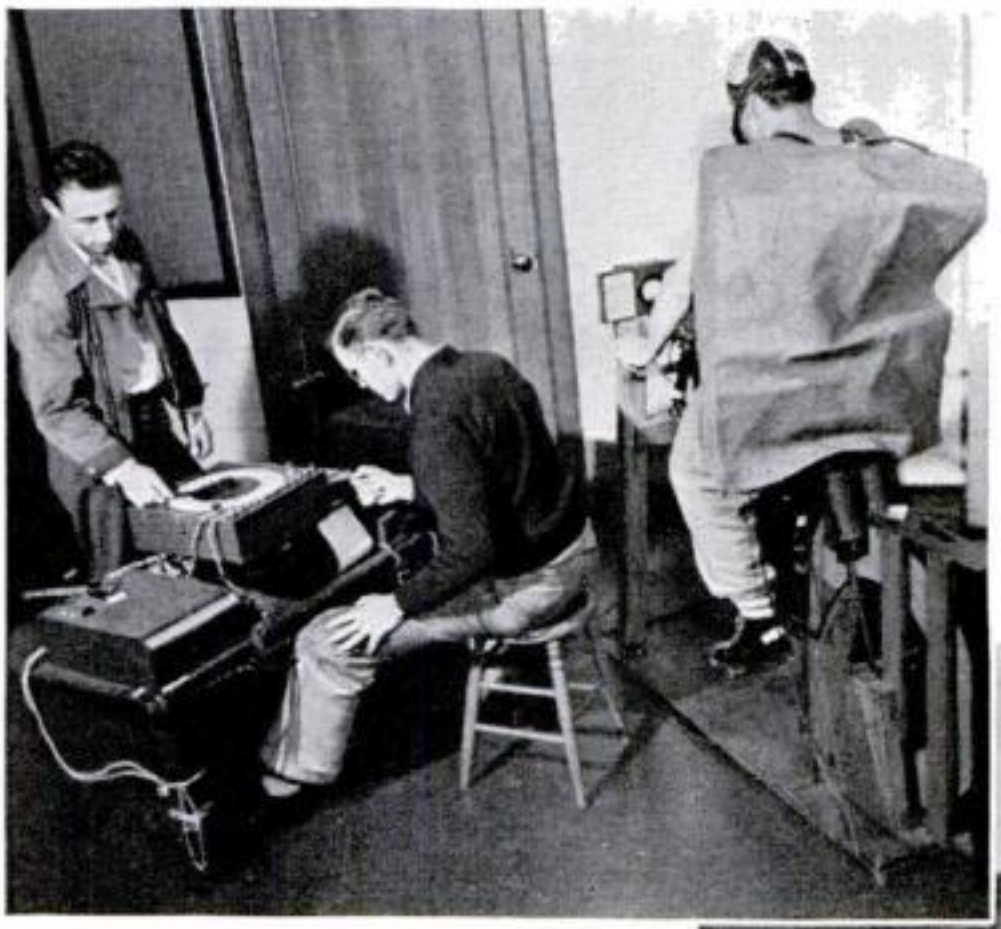
accurately while the boys move about, Dr. Henry invented a heart-beat speedometer, a portable device weighing 30 pounds and involving vacuum tubes and simple metal-plate electrodes. With it he can read both the number of beats, as recorded on a counter, and the changing heart rate itself.

This device is helping him find just what goes on in the human body during exercise. It is combined with a stationary bicycle, a large bag which collects expired carbon dioxide, pneumatic tubes which transmit breathing rate to a recorder, and 100-foot coils of pure nickel wire cemented with a plastic to copper disks to measure changing body temperatures.

In practice, these tests of physical condition will help to make possible exact evaluations of athletes' health. More than one boy has been permitted to exercise when suffering from a cold. Perhaps both his coach and he thought his physical condition was good. Yet from this laboratory has come the first scientific data indicating how a cold affects the body during exercise.

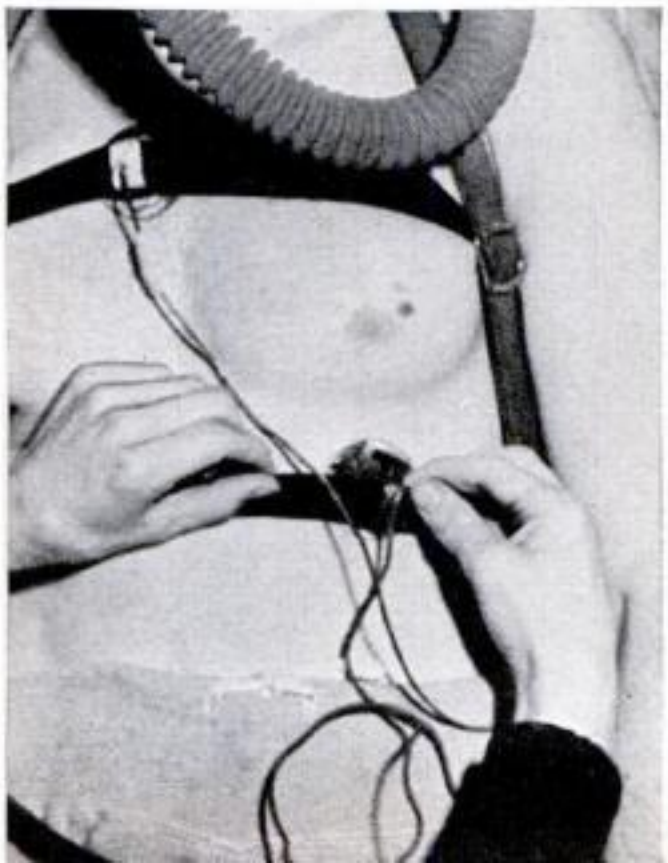
Twenty-one students with colds climbed stools and blew into flarimeters, trying to maintain a column of water at a level as long as possible. Dr. Henry's instruments recorded their heart action and breathing during exercise and subsequent rest. Their flarimeter blows dropped nearly a fifth in duration as compared to their blows when they were in good health, and they breathed 10 percent faster for a brief period following exercise, yet their hearts beat more slowly. It meant lowered vitality.

While most coaches forbid athletes in training to smoke, authorities do not agree upon the physical effects of tobacco. Dr. Henry has turned his attention to that subject, too. Blindfolded subjects smoke cigarettes and cigars, and try to hold a metal pencil in a small hole. Electrical contacts note any wavering.—ANDREW R. BOONE.



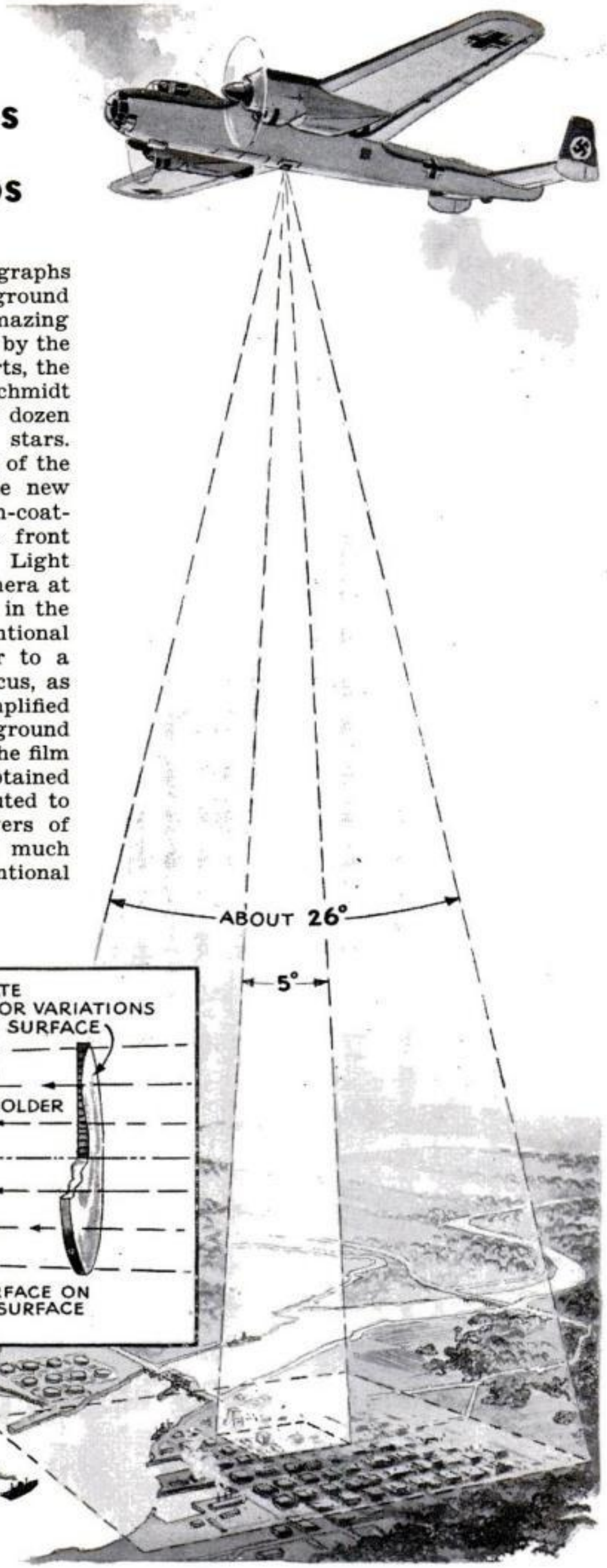
WHAT GOES ON INSIDE THE BODY is observed with the assistance of a bicycle rider and a set of instruments recording skin temperature, heart rate, breathing, and oxygen consumption. The bag retains expired air and its carbon dioxide content

Copper disks backed with 100 feet of coiled pure nickel wire measure the temperature of the body as the athlete rides the stationary bicycle



Lensless Camera for High Altitudes Gets Sharp Photos

A LENSLESS camera that photographs extremely small objects on the ground from great heights with amazing sharpness of detail is said to be in use by the German air force. According to reports, the aerial camera is patterned after the Schmidt astronomical camera designed a half dozen years ago to photograph distant stars. While the Schmidt camera makes use of the reflecting mirror of a telescope, the new camera has its own special aluminum-coated spherical mirror, plus a simple front plate that corrects imperfections. Light beams from the ground enter the camera at a much narrower angle than they do in the case of an aerial camera of conventional design. They bounce off the mirror to a convex film holder at the point of focus, as shown in the accompanying simplified sketch. While the total area of the ground covered by the camera is small, and the film itself is not large, the sharp detail obtained from high altitudes is largely attributed to the tremendous light-admitting powers of the camera as compared with the much more limited receptivity of conventional cameras using lenses.



Above, how the reflecting camera works: Light enters it as nearly parallel beams; reflects off the spherical mirror to film. In the drawing at the right, the small area covered by the new camera is compared with that taken in by an instrument of the type commonly employed

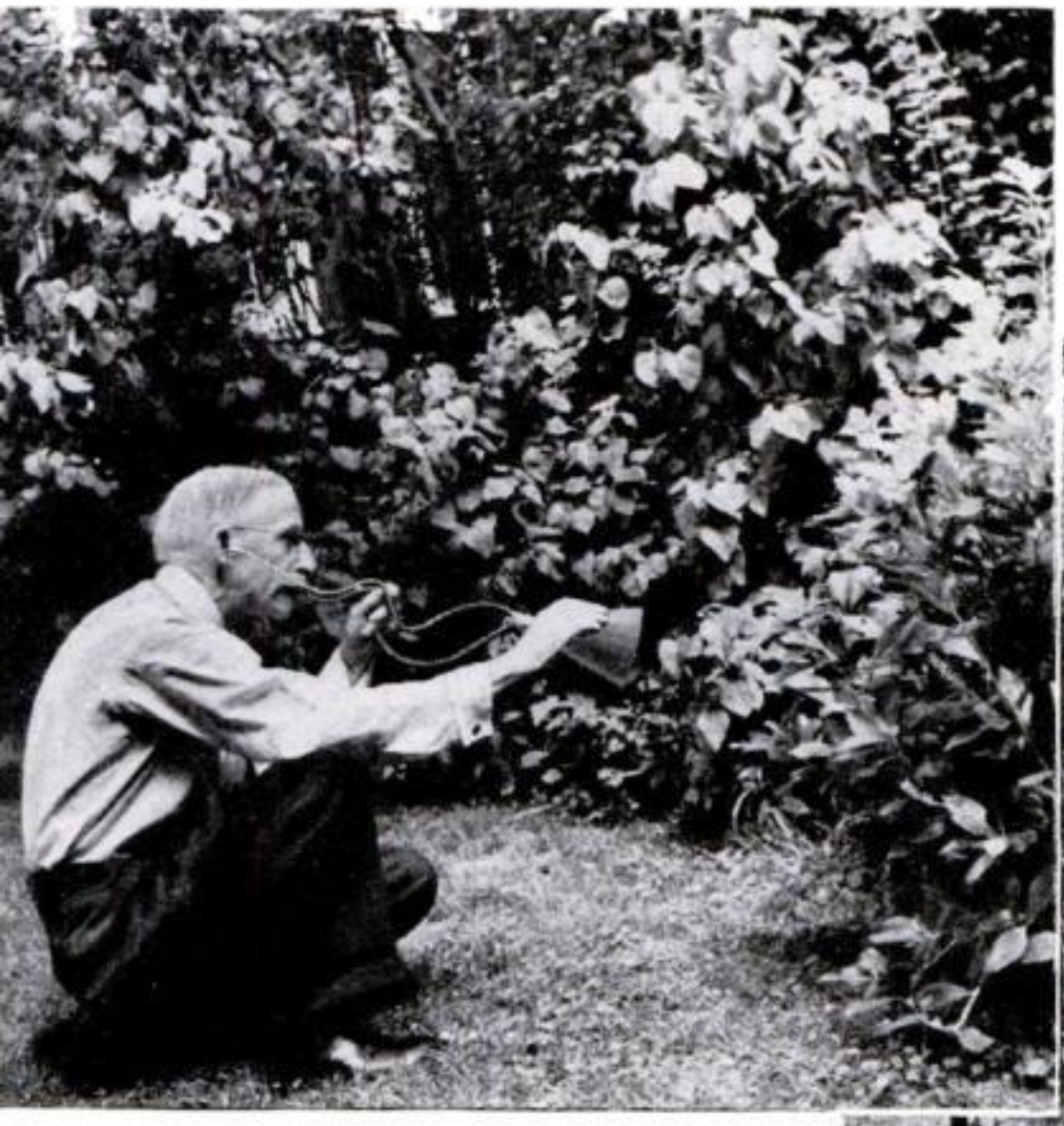
"A LOT OF INSECTS"

An Entomologist Counts the Species in His Own Back Yard—and the Result Surprises Even Him

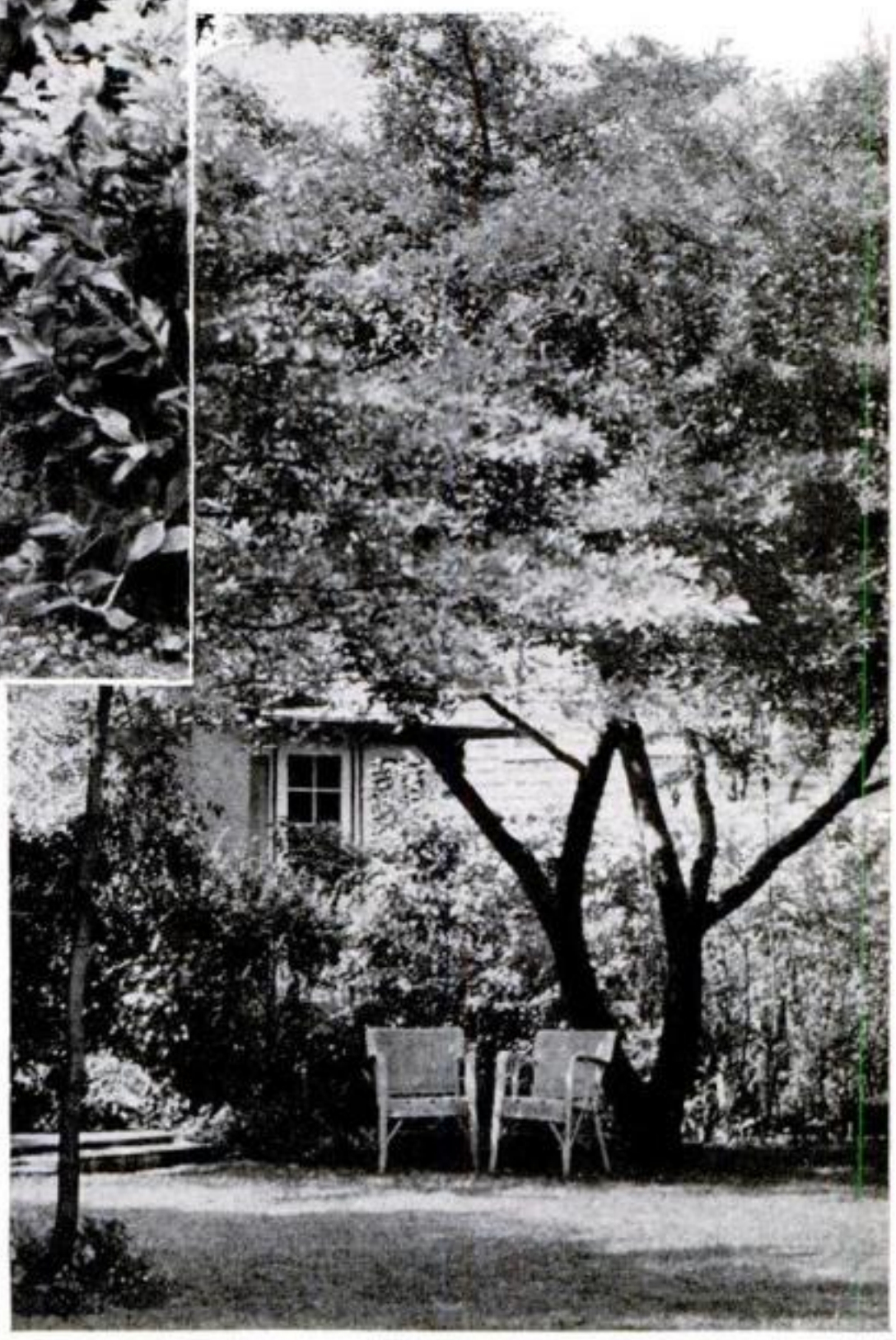
DR. FRANK E. LUTZ found 1,500 different species of insects in his back yard—and, what is more, he was happy about it! Dr. Lutz, curator of Entomology for the American Museum of Natural History, tells of his discovery in a book titled "A Lot of Insects" (The Cornwall Press, Inc.).

It all came about after a talk with Dr. Lucas, Director of the Museum. Dr. Lutz wanted a larger staff for his department. He pointed out that, since there are three times as many insects as there are birds or animals, at least three fourths of the staff of any zoological museum should be entomologists.

"Why," said Dr. Lutz, "there are more different kinds of insects that either live in or come of their own free will to my 75 by 200-foot yard than there are different kinds of birds in the



The quiet New Jersey suburban back yard below was a home or stopping place for 1,500 kinds of insects within a few years' time



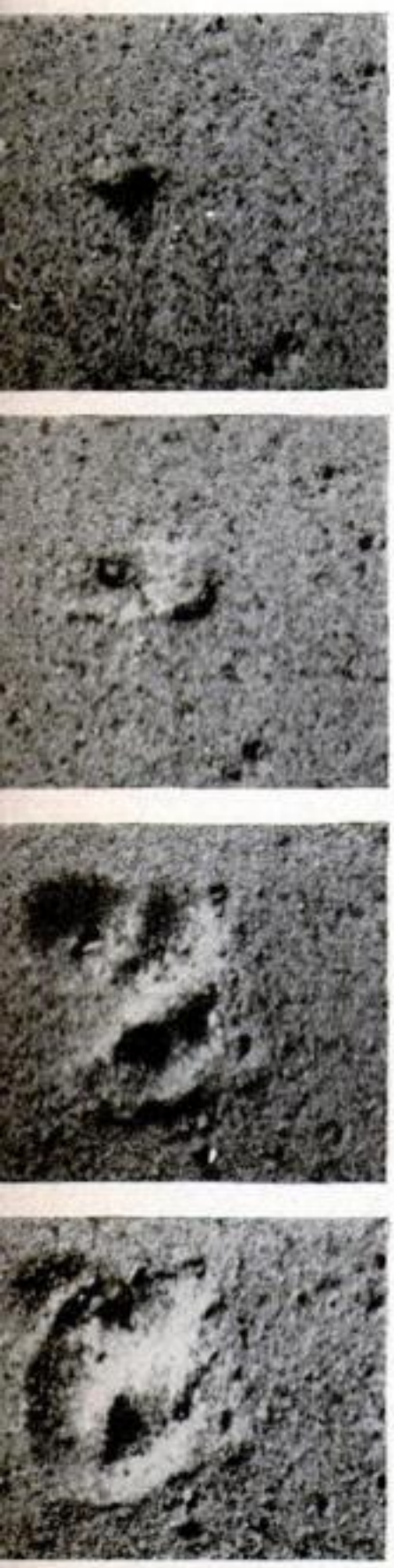
Above, Dr. Frank Lutz uses his ingenious stethoscope-and-funnel listener to locate visitors. Below is the strange mole cricket

United States and Canada!" The director smiled and remarked that this statement was an "exaggeration due to enthusiasm."

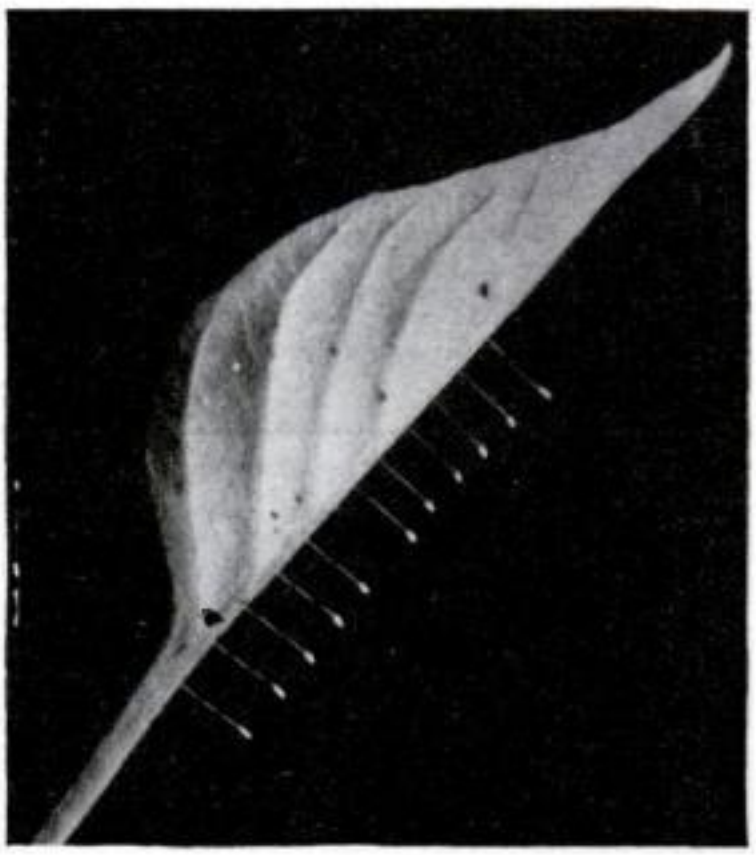
The conversation ended with Dr. Lutz betting Dr. Lucas that he could find at least 500 different kinds of insects in his back yard. Setting out to prove his claim, he made the almost incredible discovery that 1,500 different kinds of insects came to his back yard in the next few years. Some of his insect visitors came from such far-off places as the West Indies and Mexico, while others were just the home-grown varieties. One day Dr. Lutz found a tropical bee, known as the Euglossid, resting one one of his petunias. He surmised that it had been imported on a tropical plant or possibly had flown all the way from the tropics. So far as Dr. Lutz knows, this is the only live specimen that has ever been seen north of the West Indies and Mexico, though many may have escaped identification.

In detecting his noisier "neighbors," he used a simple but ingenious sound-detecting device consisting of a doctor's stethoscope and a cardboard funnel. With this strange instrument he became quite proficient in identifying the type of insect by sound. For example, he found that the cricket's chirp is a pure tone, while the call of the katydid, although made in the same way, is just a plain noise.

"A Lot of Insects" gives the reader a desire to walk observantly through his garden —book in hand—and start listing the insects he encounters.

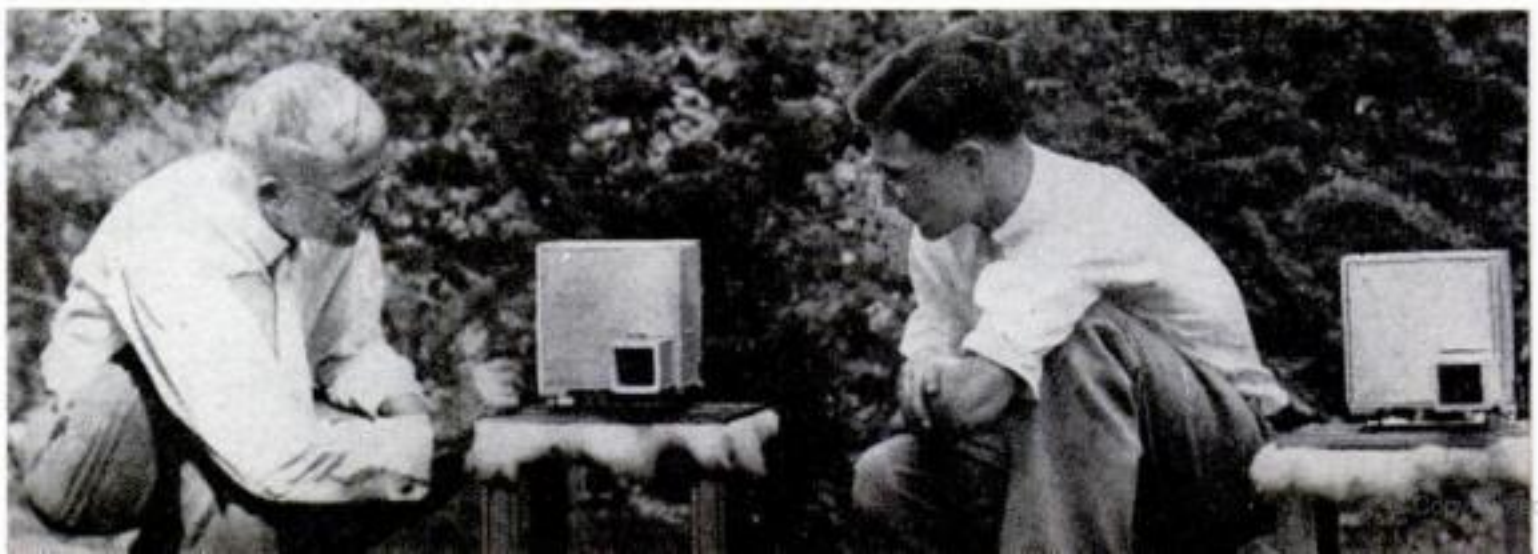


LARVA BUILDS ODD TRAP FOR ITS FOOD Photographs at left show how the ant lion's larva makes a pit in the sand to trap other insects. Backing around in a spiral, it flips sand with its head to form a neat conical pit



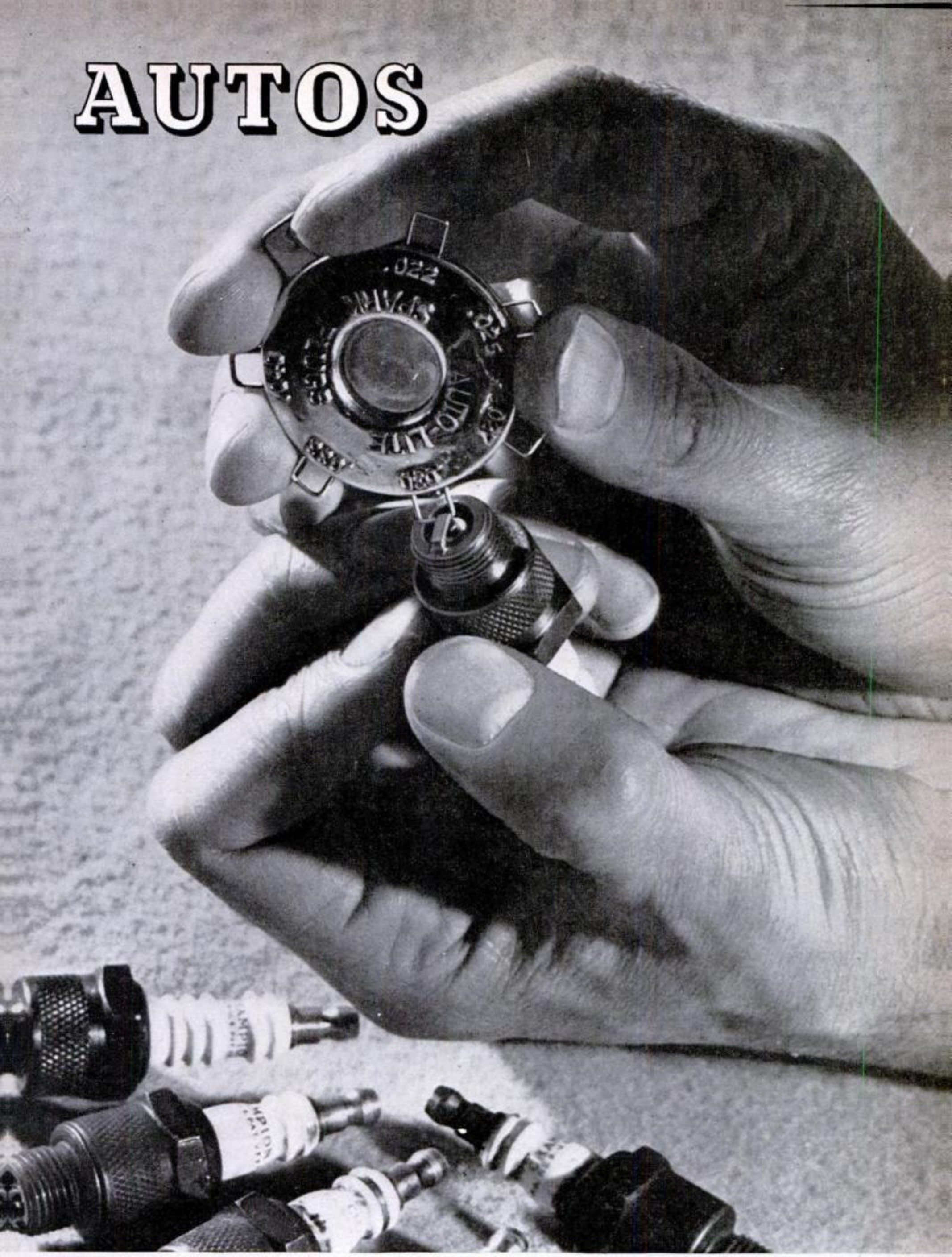
APHIS-LION EGGS hanging from a plum leaf. If eggs were not separated, first of the young to hatch would eat the others

"10" CATERPILLARS—22 of them—on a bean leaf. Huddled together this way, they look like one huge insect



TRAINING BEES to associate sounds with food. In addition to taking a census of the insect population of his back yard, Dr. Lutz made many experiments like this to demonstrate their strange characteristics and habits which are described in his book

AUTOS



What You Can Do to Save Your Car

A CAR IS AS GOOD AS ITS WEAKEST PART

By SCHUYLER VAN DUYNE

TO MOTORISTS of a nation at war, extraordinary automobile care means more than just money in the pocket. It may well make the difference between sharply restricted driving and no driving at all. No other nation is getting away with much civilian motoring. Without effort, this nation probably cannot either.

Common-sense driving, says the U. S. Department of the Interior, can cut our gasoline-consumption bill by 25 percent. And common-sense care of your car can work equal economies by making it last longer. Such care calls for a new mental conception of what your car is. Instead of thinking of it as a complete mechanical unit, look on it as an assembly of many separate parts, each one a link in a chain that, when broken, may render the entire unit useless.

Thus, while those brakes that aren't quite equalized, or that grabbing clutch, never yet made you give up driving, you should now recognize that bad brakes may destroy unreplaceable tires, and that a grabbing clutch can smash the transmission, rear end, and universal joints which you might have a difficult time getting put back in shape. In short, your car is no longer a luxury, but a consumer of vital war materials at best, and at worst a waster of them.

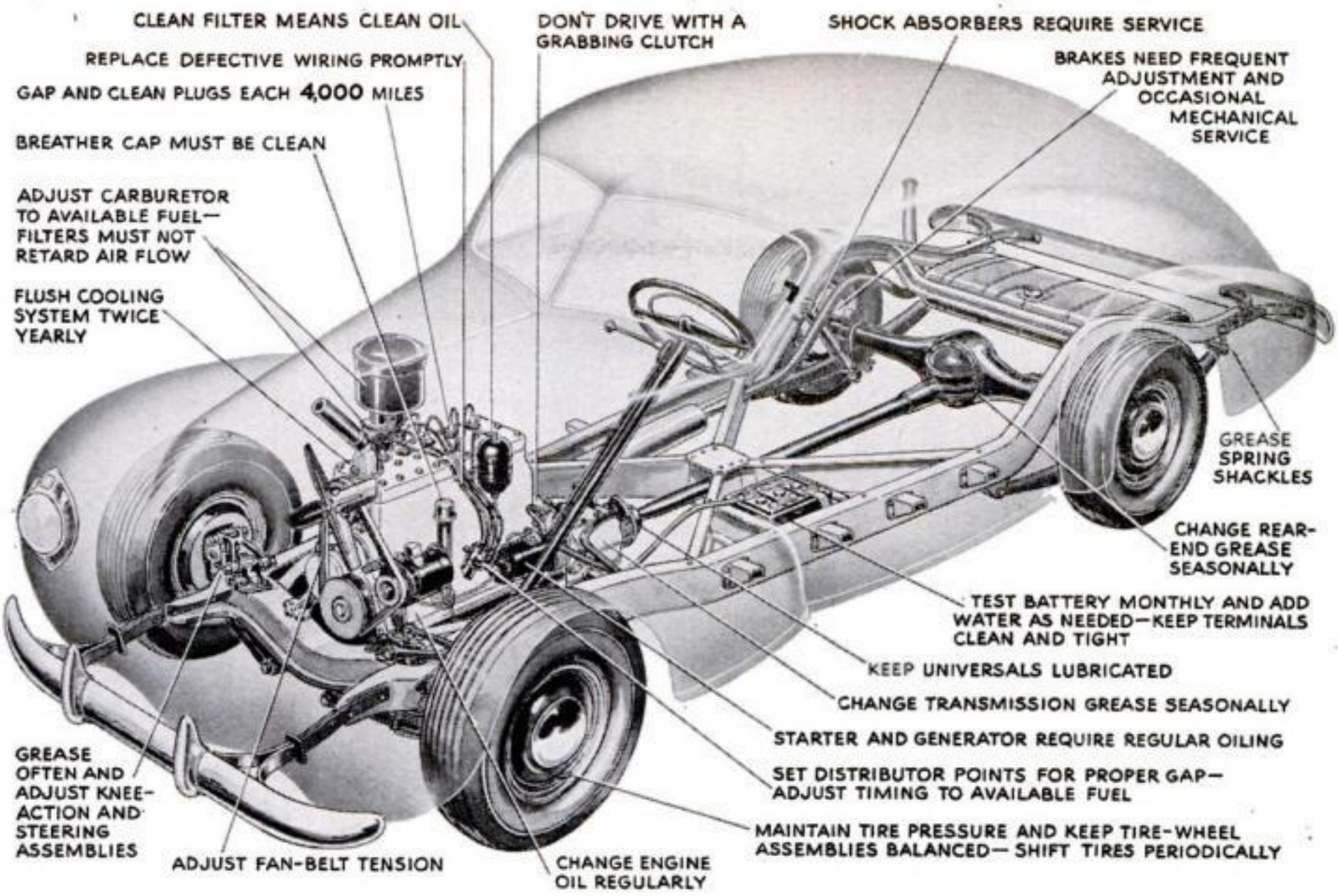
WHAT YOU CAN DO FOR DEFENSE

The principal parts of a car to be cared for are not many. Tires, battery, generator, starter, carburetor, distributor, brakes, spark plugs, air and oil filters, knee-action and steering assemblies, and a few simpler ones like the fan belt, wiring, cooling system, and lights. Let's run through the list and see why and how you should take care of them.

TIRES. They are mainly crude rubber from the East Indies. Certificates of necessity from rationing boards are now required for their purchase. To get the most from present tires, keep them pumped to the maker's recommended pressure. Check valves for leaks. Inspect frequently for cuts, bruises, nails, and for worn spots indicating unbalanced wheels, misalignment of

BATTERY. Individual cell tests show whether all cells are doing an equal share of work. Testing all cells together is necessary, too. If your battery runs down rapidly, the trouble may be in the generator, current regulator, voltage regulator, cut-out relay, or your driving habits. Batteries may soon be

WHEELS. Weights properly added to wheel rims will restore stationary and revolving balance to tire and wheel assemblies. This is vital to long tire life since a heavy spot will cause wheel "tramp." If the heavy spot is near tire edge, it also will cause wheel shimmy. Both shorten tire life, damage brake drums



Composite of several automobiles, the drawing shows the principal parts to service to keep your car running

wheels, uneven brake action, or shimmy. Rotate tire positions to distribute wear evenly. Retread, recap, or top-cap good worn carcasses.

BATTERY. Mostly lead, of which reclaimed lead is large part. There is antimony-lead alloy in various parts. Pig lead, antimony, and rubber for the cases, are all under strict wartime allocation. Add water frequently to cover plates. To be sure of ample charge, make ampere and volt tests at least once a month. Learn to start your motor on the first try. Keep battery posts and clamps clean of corrosion with occasional bath of baking soda and water, followed by clear-water rinse.

STARTER. It contains many yards of copper wire, a copper commutator, cast iron, and steel. Lead and tin are used in soldered connections. All materials are under allotment. First signs of trouble are excessive ampere consumption and reduced starting speed. Worn brushes and bearings, shorted commutator sections, and dirt and grease are the prime causes of trouble. Starter overhaul is cheap compared with new-unit cost. A defective unit will discharge a battery rapidly. Keep it oiled according to instructions, and use the unit as little as possible.

GENERATOR. Same materials as starter. Brushes, commutator, and bearings are more prone to wear. Trouble signal is intermittent or halted charging, or any unusual noise.

CARBURETOR. Considered with air cleaner and gasoline pump, it is made entirely of strategic materials—zinc, iron, copper, and steel variously alloyed. Keep carburetor adjusted to match the antiknock rating of available gasoline (P.S.M., Mar. '42, p. 135). Keep air and fuel filters clean, and don't overlook the tiny wire-mesh air filter in the automatic-choke housing. If clogged, it can cause terrific gas waste. Remove and clean with carbon tetrachloride, or replace.

DISTRIBUTOR. Strategic materials include thermosetting plastic (Bakelite), copper, steel, and precious metals (in points). Just as important as the carburetor to fuel economy, the distributor should also be adjusted to the knock tendency of the gasoline used. The points should be accurately spaced, and the vacuum spark advance and governor-controlled spark-advance mechanisms should function perfectly.

SPARK PLUGS. Materials are clay, alloy steel, and nickel. Nickel, of which the electrodes are made, is high on priorities lists, and much industrial power is consumed in baking the clay into heat-resisting porcelain insulators. Worn, dirty plugs may waste a gallon of gas in ten. Clean and adjust plugs every 4,000 miles, or oftener. Replace when cracked, badly worn, or oxidized.

BRAKE AND CLUTCH LININGS. Besides asbestos which is relatively plentiful, the materials are thermosetting plastics, tung oil and gallic acid from China (via the Burma Road), cashew-nut liquid from India, and graphite from Ceylon. Shortages appear inevitable. Gentle operation of brake and

Check Items Off This List As You Check Them On Your Car

TIRES: Pressure, wear, balance, valves —

BATTERY: Water level, terminals, charge —

GENERATOR: Lubricant, brushes, output —

STARTER: Oil, brushes, battery drain —

CARBURETOR: Wear, adjustments, filters —

DISTRIBUTOR: Spark setting, points —

BRAKES: Adjustments, cleanliness, fluid —

SPARK PLUGS: Cleanliness, gap setting —

KNEE ACTION: Lubrication, adjustment —

STEERING GEAR: Lubricate, adjust —

FAN BELT: Adjust to required tension —

COOLING SYSTEM: Flush, check leaks —

WIRING: Insulation and metal condition —

clutch pedals and foot accelerator greatly reduces tire wear and prolongs life of the brake and clutch linings and many mechanical operating parts of a car. Keep brakes properly adjusted, and hydraulic-cylinder parts (largely strategic aluminum) in good repair.

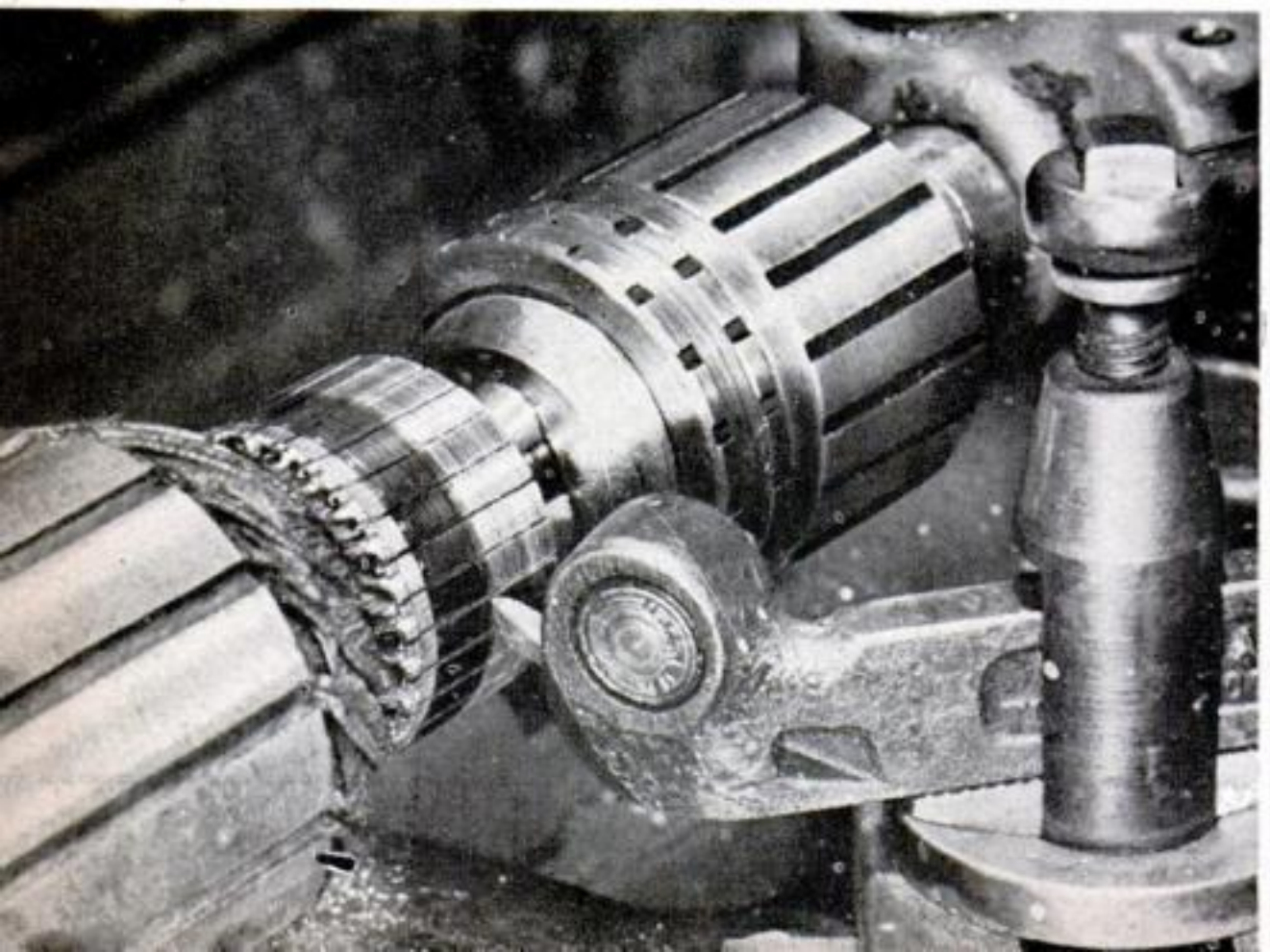
STEERING MECHANISM. All parts are of high-quality steel and iron, painstakingly fabricated, with precision-finished bearing surfaces. It is provided with steering-wheel play and front-wheel toe-in adjustments, as well as with ample lubrication fittings. Neglect of adjustments and lubrication will soon show up in poor steering, road wandering, and increased front-tire wear.

KNEE-ACTION MECHANISM. It is built of materials similar to those of the steering mechanism, requiring time-consuming finishing and fitting of bearing surfaces. It incorporates caster and camber adjustments that affect steering action, and must be regularly lubricated to prevent excessive bearing wear, noise, and tire wear.

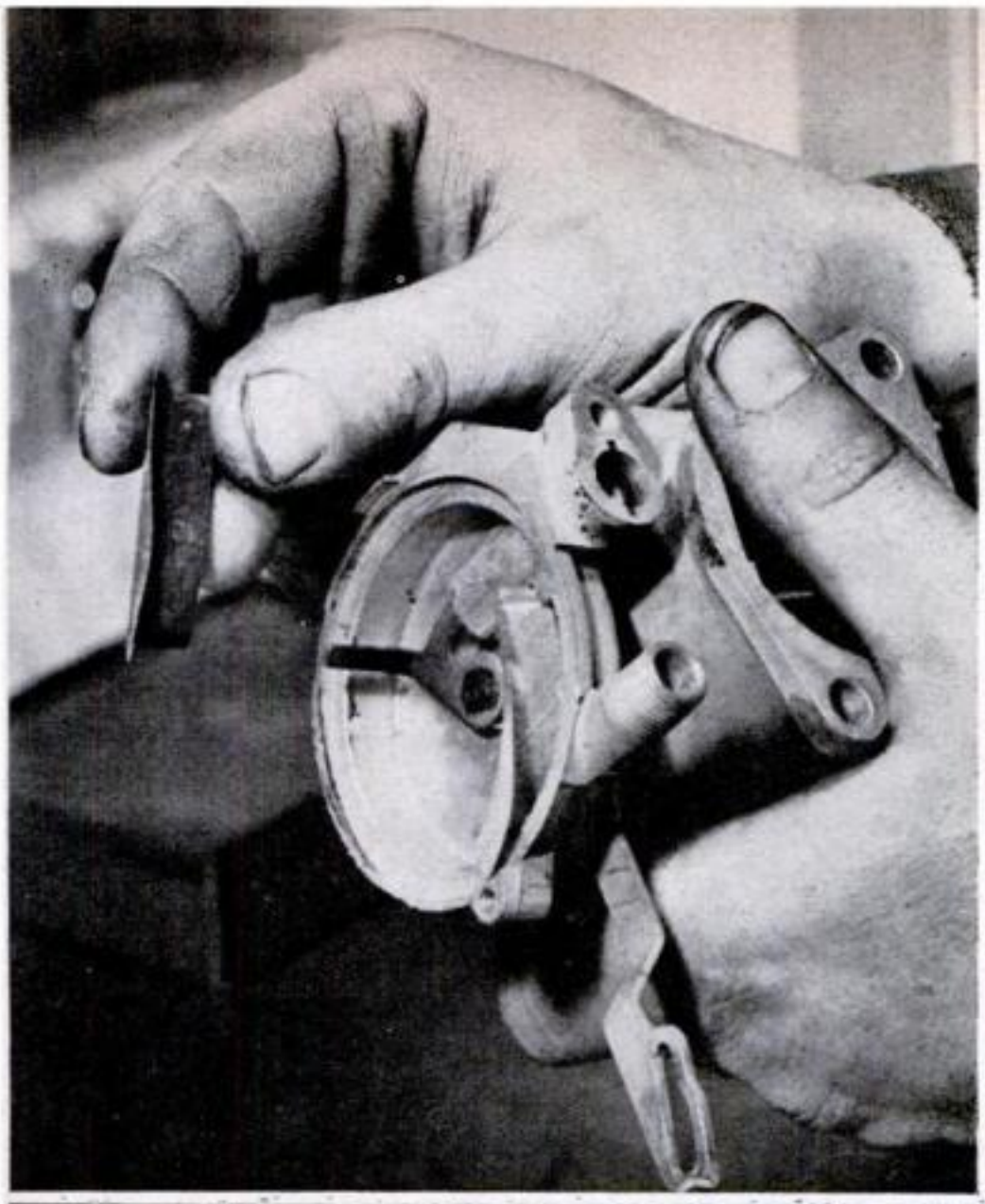
COOLING SYSTEM. The radiator is made of strategic copper. The fan belt and hose connections are largely rubber. A thorough pressure-cleaning of the radiator and the engine water jackets once or twice a year will clean out corrosive deposits, forestall damage from overheating, and increase car efficiency. Have good repairs made promptly on leaky parts. Proper tension on fan belt, usually regulated by adjusting generator position, will prevent slipping and lengthen belt life.

OIL AND GREASE. They are as much a part of a car as the carburetor is, and your car will not run without them. And like gasoline, they should be conserved for engines of war. They are a regular by-product of gasoline refining. If you can buy gas, you should not have to neglect to buy oil. Changing oil in your crank case at the recommended intervals is one of the most important of driving economies, since old, dirty oil may wear, rather than prevent wear in, engine bearings. The same applies to changing the transmission and rear-end lubricants, and frequent greasing of the chassis parts.

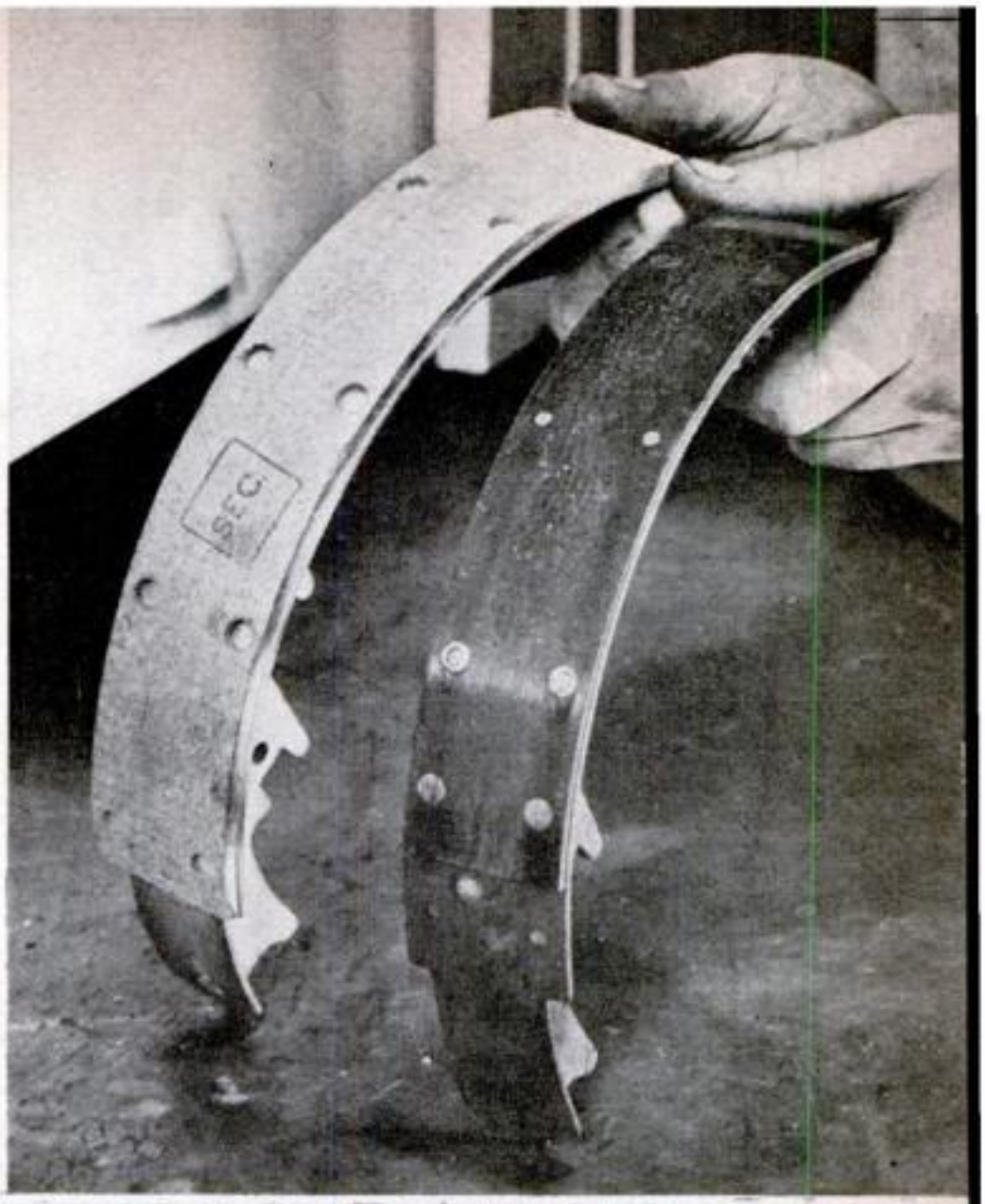
THE DRIVER. The minute he gets behind the wheel, he becomes the most important part of the car. When his time allows, he should drive at the most economical speed—generally between 25 and 35 miles an hour.



GENERATOR. This and the starting motor are built to last, but they are prone to ills caused by grease, dirt, and resulting wear. At left, the commutator sections of a generator armature are being turned down on a lathe after dirt and worn brushes have caused short circuits. Care calls for regular oiling of bearings; inspection of brushes. Neglect is unusually costly in these units. Proper maintenance adds years of usefulness



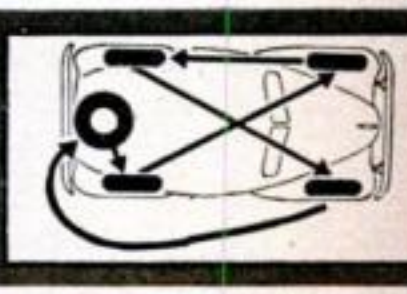
CARBURETOR. Have it adjusted for fuel economy occasionally. Then, keep its air filters clean! And don't overlook the tiny screen inside the automatic choke. When dirty, it delays reopening of the choke valve and wastes gas. A dirty one is shown above (in right hand), along with a new screen, half in place. Get at it by removing cover from the pillbox-shaped housing



BRAKES. Adjustment and careful use will determine the life of your brakes. Linings worn down to the rivets (above right) let the rivet heads gouge the drums. New linings will then have smaller surface to operate against, unless drums are refaced. Add brake fluid often, keep hydraulic cylinders working freely, and keep water, grease, and dirt from the linings

Tramping on the accelerator, racing in any gear, idling his motor for long periods, staying in low or intermediate gears when he could get along as well in high should all be taboo. He should round corners slowly, apply the brakes sooner and not so hard, and generally drive less than has been his habit. Finally, he should devote a reasonable amount of time to looking under the hood of his car. Loose fan belts; defective or broken wire insulation; oil, gasoline, and water leaks; and a host of other trouble symptoms are easy to spot when you go looking for them. Caught in time, they can be remedied before some vital "link" in the chain lets go for the duration!

TIRES. Don't let that valuable spare tire rot in the luggage compartment. Rotate it with the others every 4,000 miles, as shown at right. Keep tires properly inflated always. Repair slow leaks at once. Avoid jack-rabbit starts; sudden stops. Remove nails, glass, stones from treads frequently. Take curves slowly. Never speed

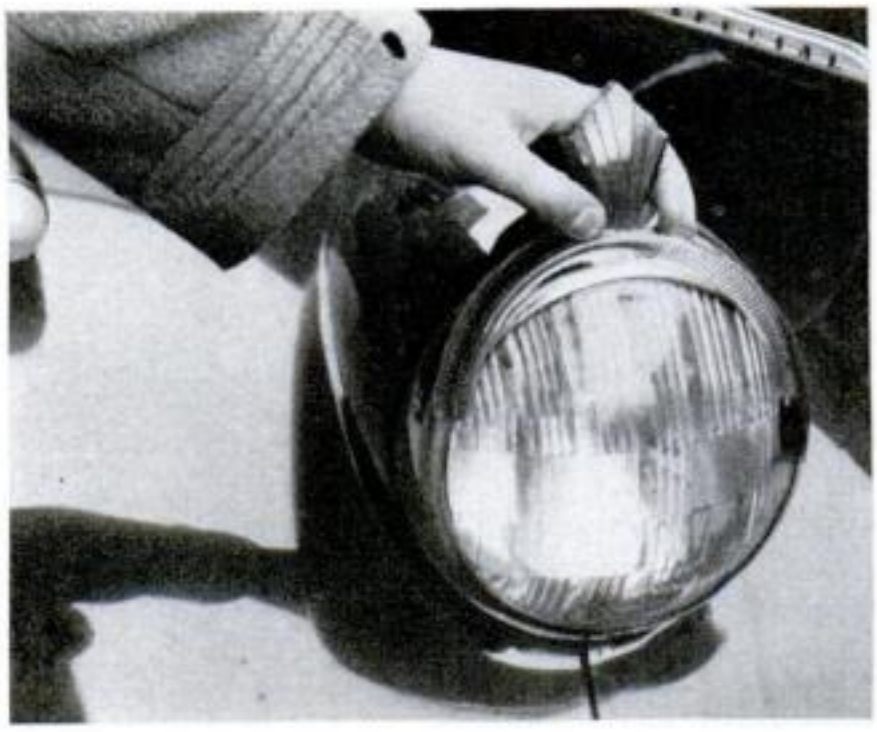


There are three types of tire retreading. This is a full retread, with new

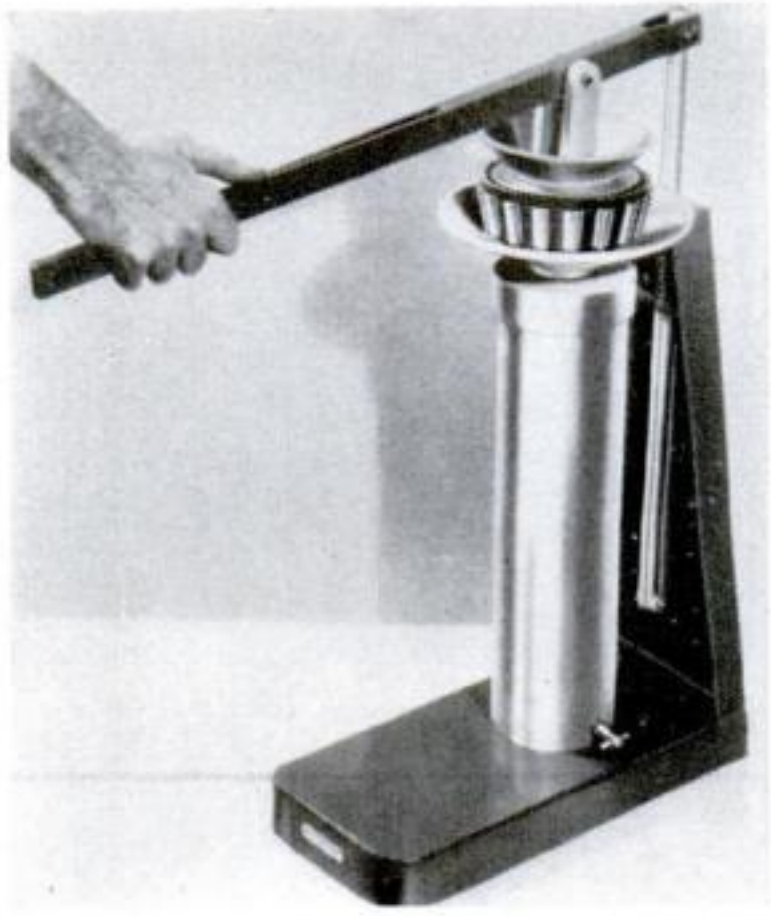
This is a full recap. Note that the old breaker strip (fabric-rubber strip just

A simple top cap. In each case, new material is the "camel-back." Tread condi-

Auto Ideas

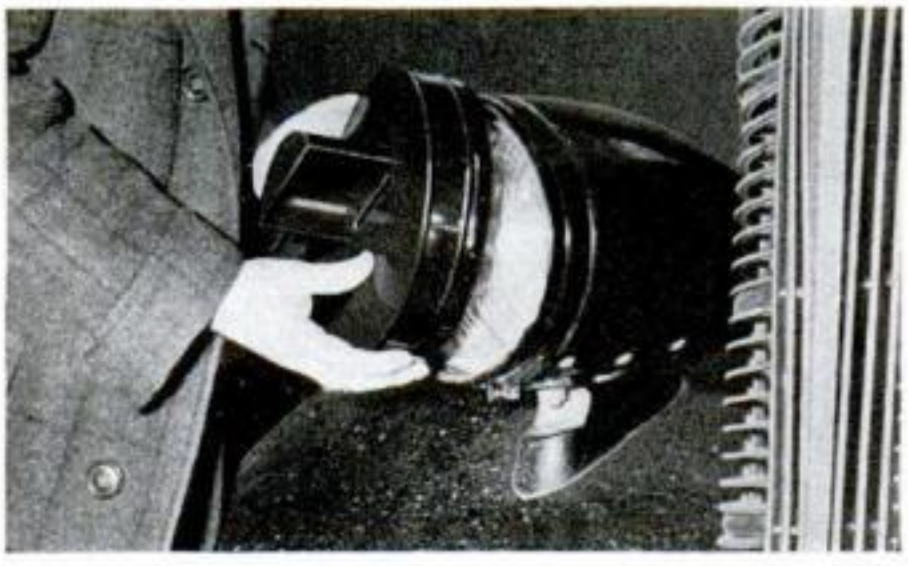


FOG-LAMP LENSES that fasten to the regular headlamps also show the driver that each headlight is lit. Made of transparent plastic, the thin filters are attached under the rim of each headlight. They also are available for sealed-beam lamps. A medallion at the top reflects a warning glow to the driver.



A WHEEL-BEARING PACKER that fills either ball or roller bearings with grease quickly and thoroughly has just been introduced. To operate the unit, illustrated at the right, the bearing is placed on top of the cylinder and pressure is applied to the lever, forcing the grease upward through the bearing parts from a reservoir of 5-pound capacity in the base. Taking bearings from 1½ to 7 inches normally, it comes with an adapter for packing those of still smaller size.

BLACKOUT SHIELDS FOR CAR LIGHTS, designed by experts in the U.S. Department of Justice, have passed rigid tests for their light-shielding powers on city streets and open highways. Fitting over existing head and tail lights to which they may be applied easily and quickly, the shields are shown being adjusted to a car by a Justice Department official in the accompanying illustrations. Finished in dull black, the units cover the light lenses except for a thin horizontal slot near the lens center. A flat beam of light emerges from the slot at a downward angle to illuminate the road. Above the slot, a black, awninglike shade extends away from the light cover to prevent stray rays of a lamp from shining upward to become visible to pilots of airplanes overhead. The shields, which attach directly to existing lights, have been adopted for use on the official cars of the Federal Bureau of Investigation.



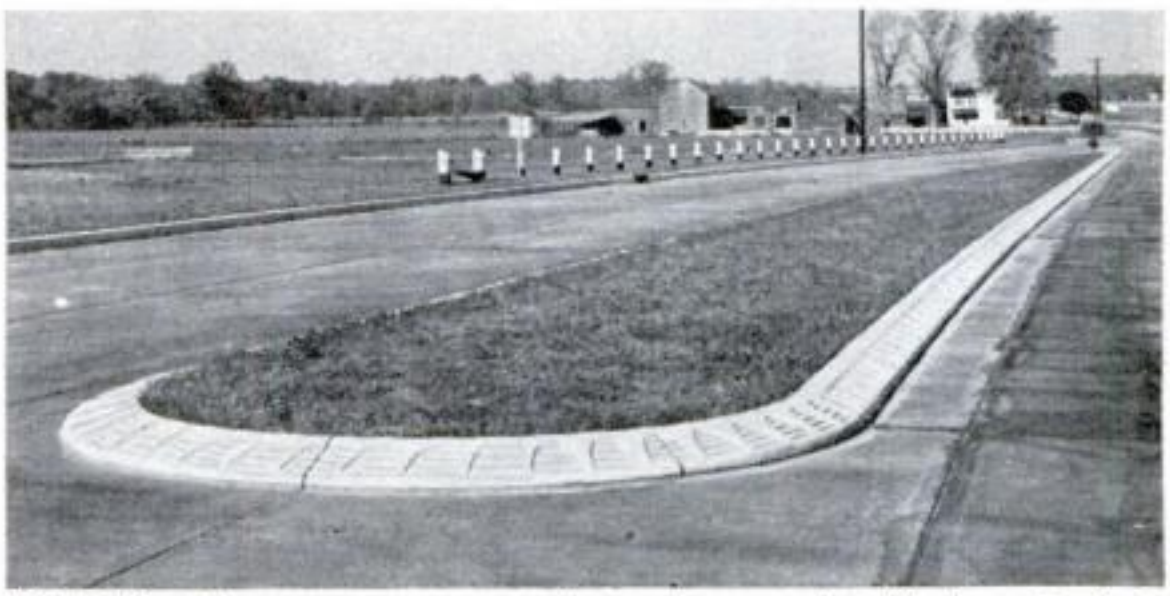
Fitting over car head and tail lights, the blackout shields, above and left, hide light from plane pilots

REFLECTING CURBS AID NIGHT DRIVERS

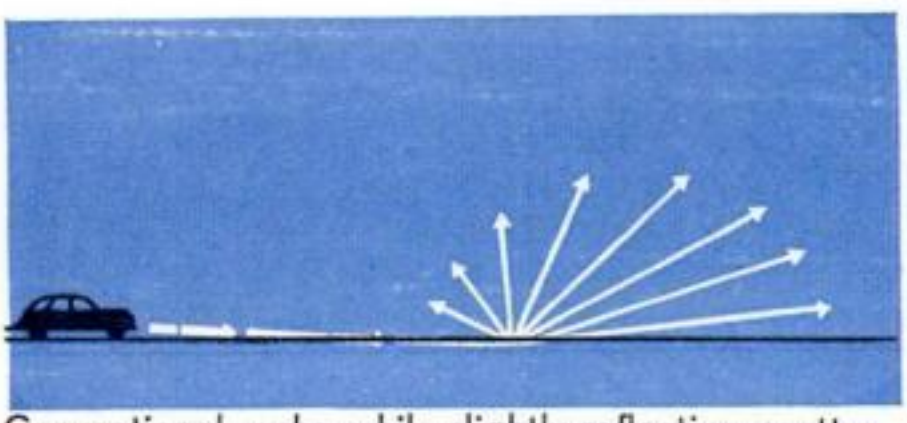
WET NIGHT. Rain increases the visibility of the new curb, heightening the reflective power of its surface

SHARPLY outlining highways by the reflected light of car headlights at night, and more clearly defining them by day as well, white concrete curbs with saw-tooth grooves on the face are making travel safer for motorists. Two simple optical principles account for the increased visibility over older types of curb. The first is that white reflects more light than gray; the second, that a smooth surface scatters light less. The smooth-faced, saw-tooth edges are designed so that one plane is at right angles to the rays of car headlights, thus reflecting light back to the driver and making the surfaces highly visible at night. Rain, which tends to obscure ordinary curbs at night, actually increases the reflecting powers of the new-type barriers.

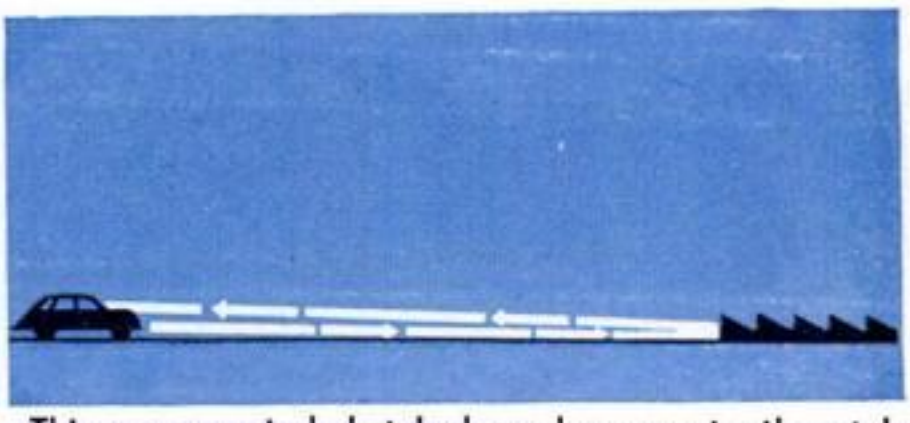
ANY NIGHT. Many saw-tooth ridges covering the white concrete present right-angle planes to car lights, reflecting beams to the driver



BY DAY. The same scene as shown by car headlights. Curb is highly visible because it is white and contrasts with surroundings

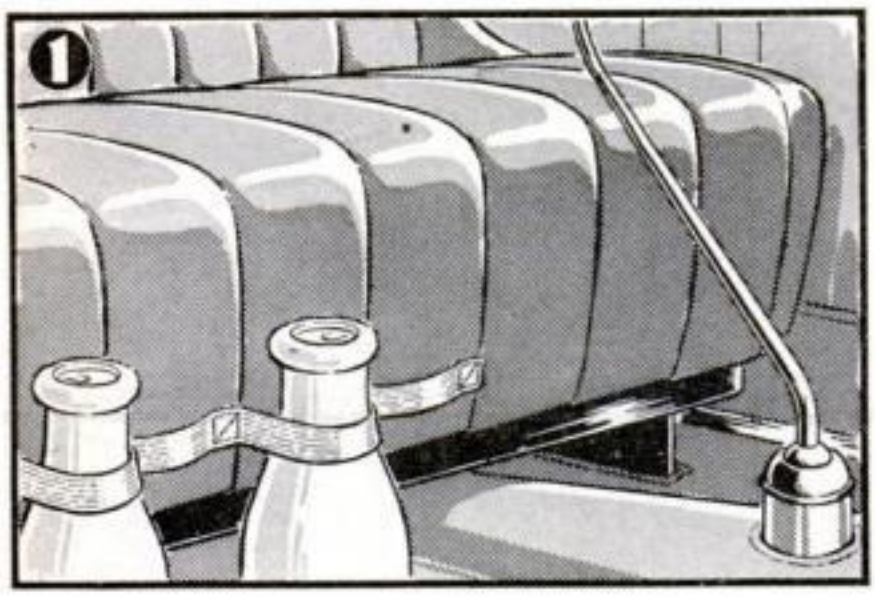


Conventional curbs, while slightly reflective, scatter light beams that they break up. Few reach a driver



This exaggerated sketch shows how saw teeth catch light from car and reflect it strongly to define curb

EIGHT HANDY IDEAS



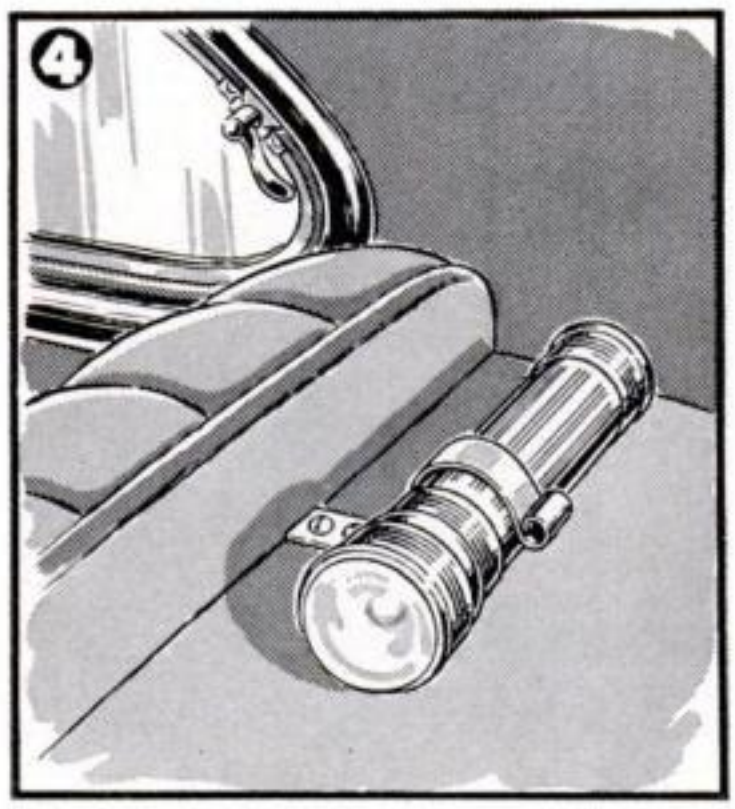
1 **BOTTLES WON'T TIP OVER** on the way home from the dairy or store if they are held upright on the floor by the simple expedient illustrated at the left. A strip of elastic tape sewed to the upholstery of the front seat in the manner shown provides loops under which the top of each bottle can be slipped and held securely.—D.S.

2 **CLEAR NAIL POLISH** brushed over the sill of the door beside the driver's seat will prevent the paint from being worn off by repeated pulling on the sill to close the door, or by the rubbing action of your sleeve if you drive with one arm resting on the sill. The polish will last a long while and scarcely shows if carefully applied.—J.E.R.

3 **FOR DIRECTING CARS** in parking stations, attendants will do well to make this simple flashlight accessory. It consists of a disk of cardboard with an arrow-shaped opening cut out of the center, and a piece of red (or green) transparent cellulose pasted over the opening. Inserted behind the flashlight lens, the disk displays a bright-colored arrow which the attendant can use to direct motorists to make proper turns in crowded parking lots.—H.H.

4 **A HANDY PLACE TO KEEP** an extra flashlight in your car is behind the rear seat where most cars have a wood or composition-board shelf. Make a metal clip or holder and screw or bolt it to the shelf so that it will grasp the light tightly, yet permit its easy removal for use.—A.R.

DRAWINGS BY
STEWART ROUSE

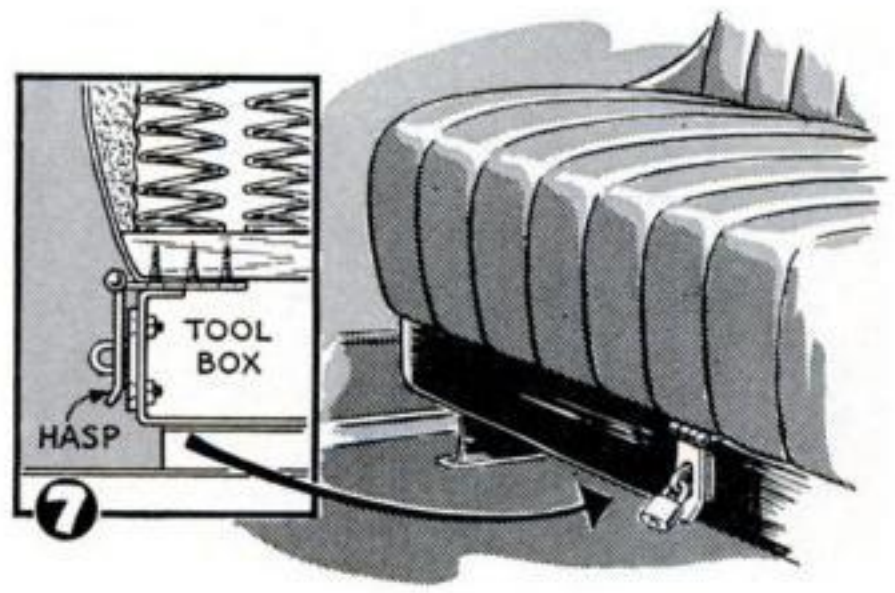


TO HELP MOTORISTS

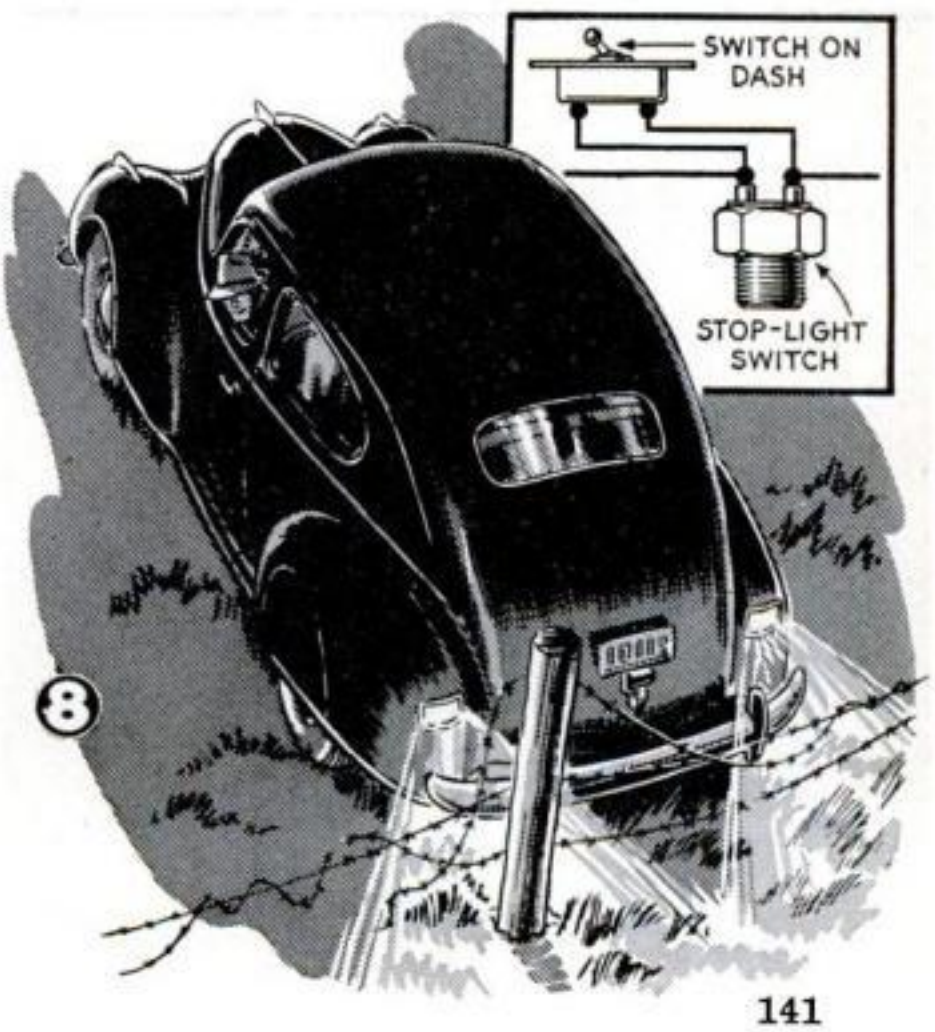
5 A HANDY KNEELING PAD for changing tires is convenient to most motorists without their realizing it. It consists of the rubber mat on the floor of the luggage compartment. Easily slipped out and spread on the ground beside a wheel, it can be brushed clean after use with much less trouble than is required to clean your clothes.—J. V.

6 WITH A DOME LIGHT installed as shown in the right-hand sun visor, front-seat passengers have a highly useful source of illumination. Inexpensive units can be obtained from junked cars, and installation will depend upon the design. Besides serving as an over-all light source for the front compartment, the light makes an excellent reading lamp when the visor is turned down and to one side.—M. M.

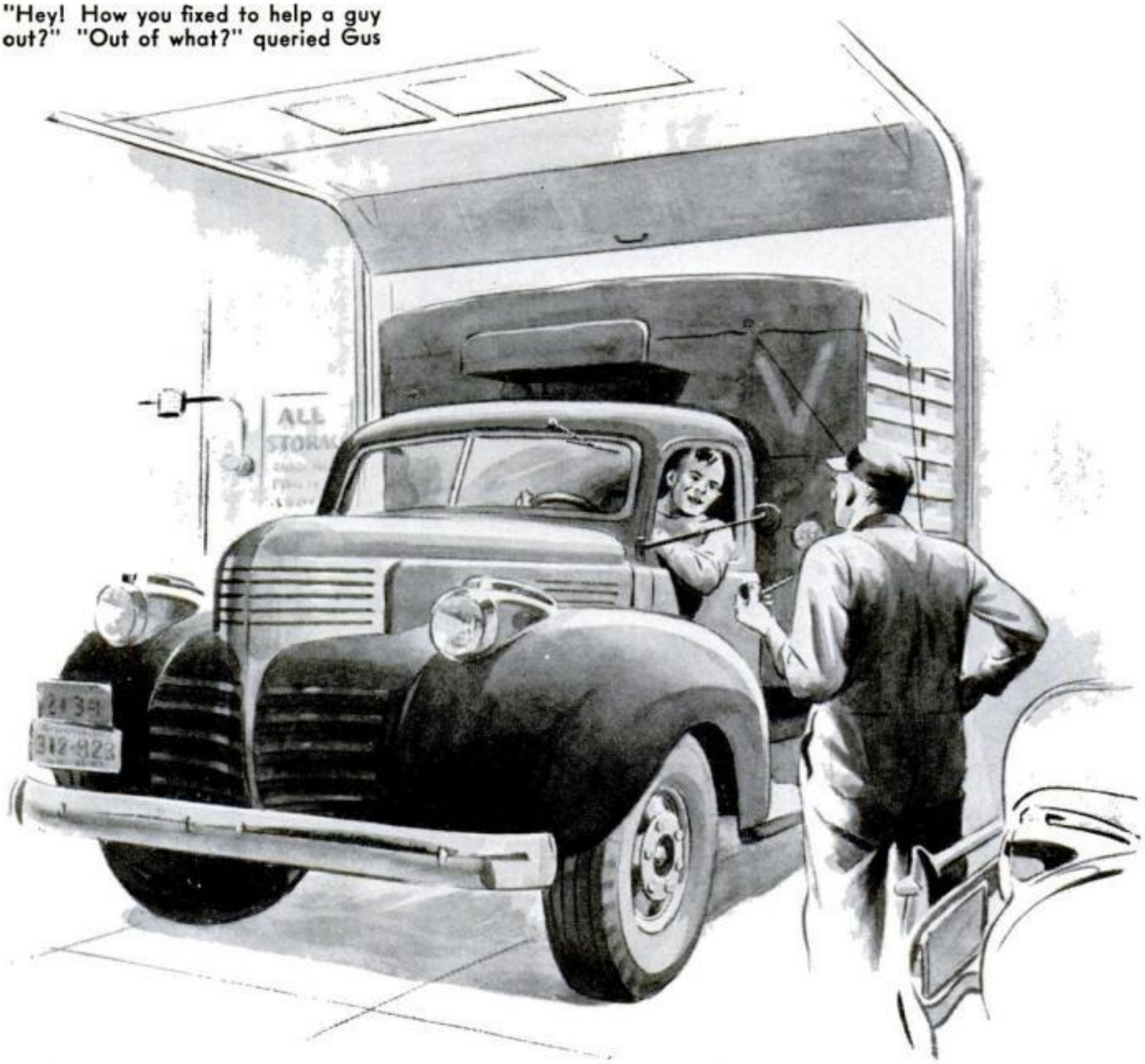
7 A HASP AND PADLOCK will keep the front seat of a car from being raised, thus preventing theft of valuable tools. Since front seats usually are held down at the back by the back of the seat, only the front need be secured. Either nuts and bolts or strong wood screws should be used, depending on whether fastened to steel or wood—H. W. S.



8 BACKING LIGHTS, using the relatively strong light of your stop lights, can be improvised in the manner illustrated. Carefully connect the terminals of the stop-light switch with wires leading to a switch placed conveniently on the dashboard—D. B.



"Hey! How you fixed to help a guy out?" "Out of what?" queried Gus



GUS has an "easy" day

That's What Joe Clark Thinks, But Then All That Joe Has to Do Is Sit and Make Out Monthly Bills

By MARTIN BUNN

IT was close to nine o'clock on a cold, sunny, late-winter morning when Gus Wilson drove his ancient and immaculate roadster into the Model Garage's shop. That's late for Gus, but he's been coming in a little late most mornings recently—he's been staying on at the shop every evening for the past month or so, working out a contraption that he's going to send to the National Inventors Council down in Washington with what we all think is the well-founded hope that it will help along the good work of making the Axis considerably less of a nuisance than it is at present.

Wally, the grease monkey, looked up expectantly from the inner tube he was patching. "Hi!" Gus said briefly. From the office came the sound of Joe Clark's industry as he slowly typed out the customers' monthly statements. A moment later he stuck his thin face in at the shop's office door, his eyes expectant behind his rubber-tired specs. "Get it yet, Gus?" he demanded.

"Nope," his partner told him. Joe looked

disappointed. So did Wally. Gus silently filled and fired up his pipe and began to shift into his work clothes. Part way through the job he stopped with overalls half on and half off and sat motioniess staring at the shop wall.

"Got it?" Joe and Wally demanded in chorus.

"No!" Gus snapped.

The rest of Joe Clark's anatomy followed his face into the shop. "You can't keep this up!" he exclaimed. "A man can go without his natural rest for just so long and no longer. You've been working here until two or three or four o'clock in the morning every night for the last three weeks—I know, because Jerry Corcoran patrols this road at night now, and he told me. You got to take some thought of your health, Gus. You got to remember you ain't as young as you used to be, and—"

That one prodded Gus out of his abstraction, and he laughed. "Nope," he admitted, "I'm not as young as I used to be. So what? I can work longer on a stretch than I could when I was twenty, and get a darned sight more accomplished in the same length of time. Habit, I guess it is, mostly—I've been working for a whole flock of years. Darn it, Joe, what gets my goat is that I've *almost* got it! If I only can iron out that one last little kink, that gadget will do its job! Oh, well, I'll get it. Tonight, maybe."

He looked around at the cars in the shop. "This ought to be an easy day. All nice, straightaway jobs—the sort of work that I can make Wally here do the most of. Go on back to sending out the bad news, Joe, and stop fussing about me." He finished pulling on his pants, and gave his partner a friendly dig in his skinny ribs. "Scram out of here! You're worse than an old woman."

Joe shrugged his shoulders helplessly and went back into the office. Gus puffed gray smoke for half a minute, and then asked Wally what he was working at. Wally had just started to tell him when a voice said:

"Hey, Mac! How you fixed for time to help a guy out?"

Gus looked in the direction of the open shop door and saw that the owner of the loud voice was a big-chested young fellow who wore an expressman's cap tilted over his left eye. "Help a guy out of what?" he queried.

The expressman grinned. "Out of trouble," he supplemented. "I've got a rush delivery to make up in Providence—war material with priority labels plastered all over it—and my engine's missing something fierce. I'm scared to take the time to get it fixed, but I'm more scared to go on with it the way it is."

"Drive her in and we'll have a look," Gus directed.

The expressman drove a light truck into the shop. Its engine was sputtering. Gus quickly checked the spark plugs and the ignition. He could find nothing wrong with either, but there was no doubt that the back two cylinders were missing. He got out the tester and checked the compression. It wasn't quite as high as it should be, but all the cylinders were about the same, and it wasn't nearly low enough to cause missing.

Gus scratched his head reflectively, and then looked at Wally. "Here's a job for you to sharpen your wits on, Kid," he said. "Everything seems O. K., and yet the back two cylinders aren't doing their job. How come?"

"Carburetor?" Wally suggested, not too hopefully.

"Nope," Gus said. "If the carburetor was screwy the other cylinders would buck once in a while. Let's have a look at the intake manifold. Looks all right. We'd better check the vacuum."

Wally brought out the vacuum tester, and Gus took off the windshield-wiper hose and replaced it with the tester hose. The tester showed poor vacuum. "The wiper hose leaking might cause that miss," Gus said, "although I don't think that's what it is. But try a new hose."

The new hose didn't make any difference in the performance of the engine. "I'll have to road-test this bus," Gus decided. "Come on, Buddy, we'll take a little ride."

When they came back after a short run up the road Gus was looking puzzled and the expressman was looking worried. "She misses worst when she's pulling on the

Water spouted from the panel. "Golly!" cried Gus. "I'd have been less surprised to see elephants!"

hills," Gus said. "But I still don't see. . . ."

"Look here, Mister, I've got to get to Providence in a hurry," the express driver broke in.

"Take it easy," Gus advised. "Before you can fix anything you've got to make sure what's wrong. The first hour you're on the road with your bus running right you'll more than make up the time you're losing now. Give me that vacuum tester again, Wally. I've got an idea."

He again substituted the tester hose for the wiper hose. But this time the engine began to run smoothly and without missing, and the vacuum reading was high.

"Huh!" Gus grunted. "We've found *where* the trouble is, but we've still got to find out *what* it is."

He did some hard thinking for a few seconds, and then pushed the tester hose a fraction of an inch farther up on the vacuum outlet. At once the engine began to miss.

"That's the tip-off!" Gus said. He raised the hood and began a rapid examination. "Here it is!" He pointed to the brass outlet for the wiper hose on the intake manifold near the back cylinders. "That outlet is cracked around its base, and that makes the cylinders draw in too much air and not enough gas. This engine is rubber-mounted. The old wiper hose is a little too short—some one has cut pieces off it, two or three times, and it was stuck to the outlet. So every time you speeded up your engine suddenly, or the truck hit a bump in the road, there was a jerk on this cracked outlet. Those repeated jerks made it crack more and more, until the opening was large enough to let the lean mixture into the back two cylinders, and that caused the missing and the loss of power on hills. Cheer up, Buddy—it won't take long to put in a new outlet."

After the expressman had driven off with his priority load, Gus and Wally worked peacefully on a transmission job until about three o'clock. Then a horn honked outside and a business coupe of popular make and current vintage was driven in and stopped short. A peevish-looking man jumped out.

"Name's Hopkins," he snapped. "I travel for a living, and I have to do it fast. Last couple of days I haven't been able to get more than fifty out of my car after three o'clock in the afternoon. What's—"

"Wait a minute!" Gus interrupted him. "What'll your bus do *before* three o'clock?"

Hopkins grinned. "Seventy—and up," he said. "Until about three o'clock. What's the answer?"

"It's somewhere in the car," Gus said. "Want me to look for it?"

"Yes!" Hopkins grated. "But don't waste time looking in places I've paid a half dozen other mechanics to look in the last two days. The fuel pump is O. K. There's nothing the matter with the carburetor. The coil is perfect. So is the condenser. Same with the distributor and the spark plugs. The gas line has been checked. Well—what?"

Gus scratched his ear reflectively. "Get your tank filled any particular time?"

"Yes," Hopkins said. "Last thing in the afternoon."

Gus got a quart can, filled it with gasoline, and put it on the floor of the car. Then he took a length of rubber tubing, connected one end of it to the fuel-pump inlet, and dropped the other end in the can. "Step on her," he directed. The engine ran perfectly. "Speed her up!" With the throttle open it ran as perfectly.

"Switch her off," Gus said. "The trouble is in your gas tank, I'll have to remove it."

"You will, hey?" Hopkins said grimly. "Suppose the trouble *isn't* in the gas tank?"

"Then you don't pay anything for the job, and I buy you a quarter cigar," Gus told him.

Hopkins grinned. "You're a sport," he said. "Go to it. I'll be back in an hour."

Gus removed the tank from the car, observing a very slight inward bulge in the tank bottom. "Good heavy rock must have flown up from a wheel to do that," he remarked to Wally as he worked.

He removed the outlet and fuel-gauge assembly from the top of the tank. Then with a ruler he measured the distance to the tank bottom and compared it with the length of the riser pipe. Then he laughed. "That pipe which feeds the gas from the bottom of the tank to the fuel line must sit right on the bottom when the tank is half empty. When it's full, the weight of the gas pushes the metal bottom down just enough to let the gas run into the pipe. Take over, Wally."

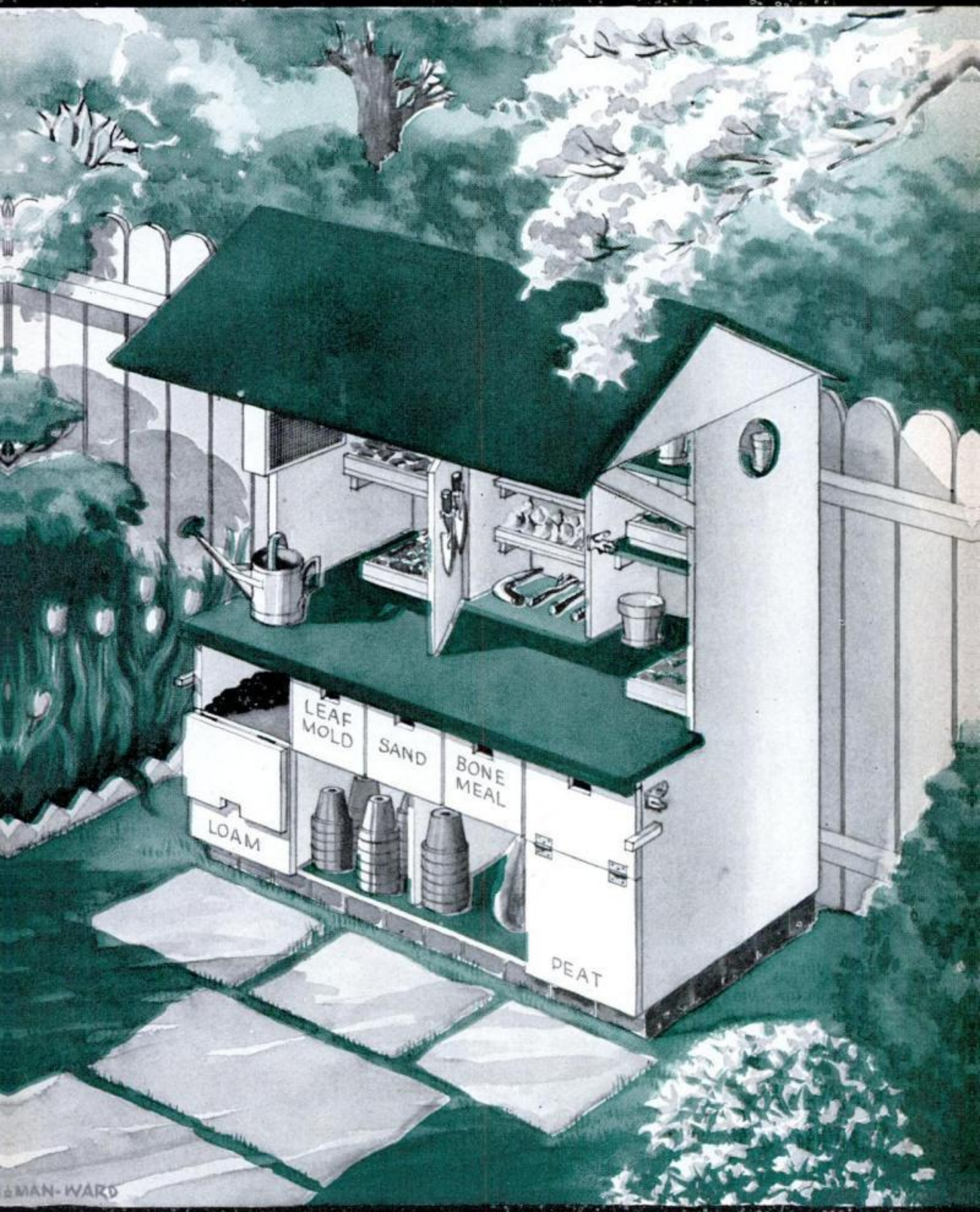
After that things went along smoothly until nearly five o'clock, with Gus doing more thinking about his defense gadget than about the work he and Wally were doing.

Then Jim *(Continued on page 218)*

GUS SAYS:

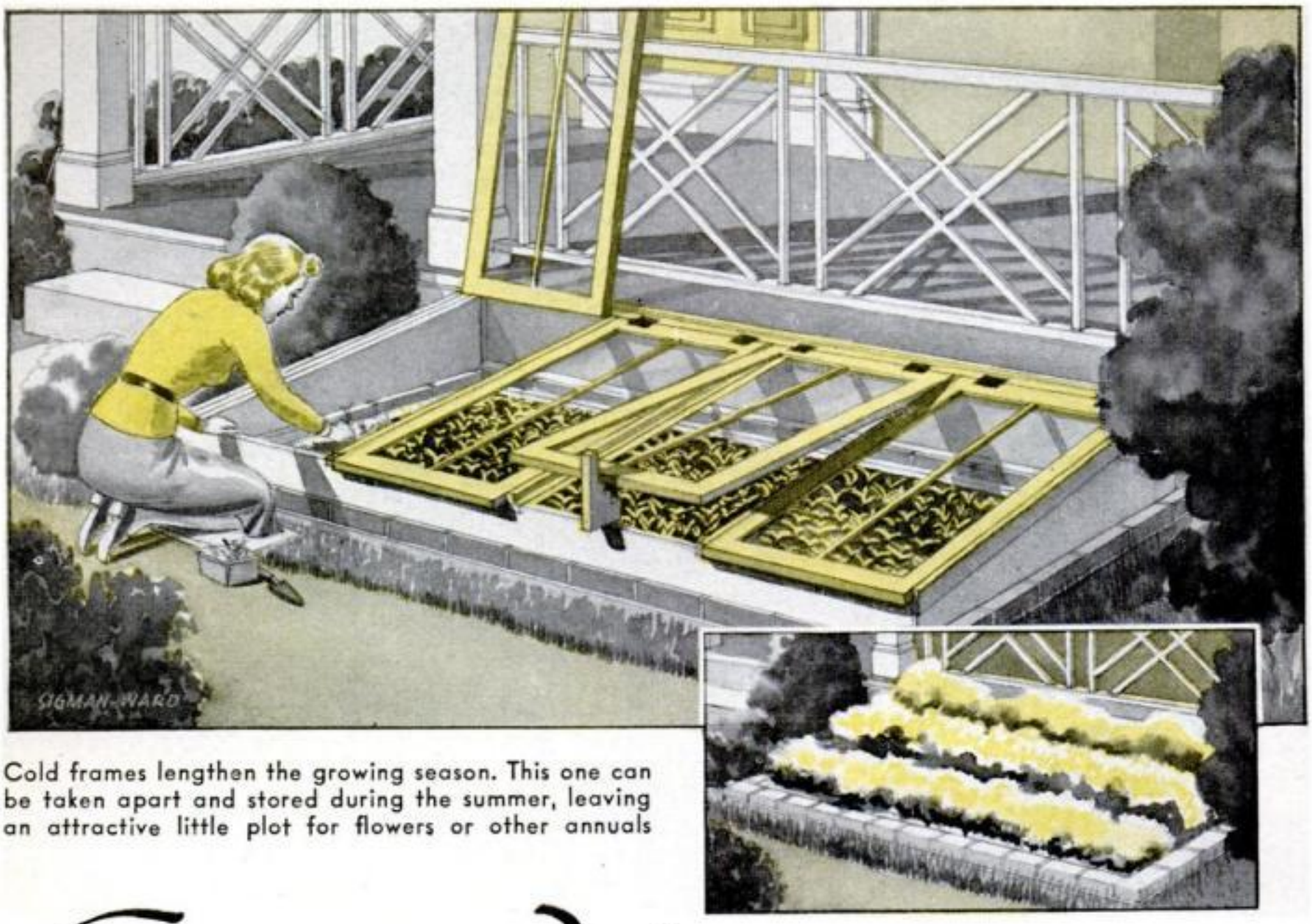
When motoring was still a novelty, drivers would enjoy bragging if they got good gas or tire mileage. Then they got out of the habit. It was pretty good sport, though, and it's a good time right now to revive the old pastime!

HOME *and* WORKSHOP



How to build an outdoor potting bench and a variety of other conveniences for the home gardener

NEXT PAGE



Cold frames lengthen the growing season. This one can be taken apart and stored during the summer, leaving an attractive little plot for flowers or other annuals

Garden Utilities

. . . TO AID IN GROWING "VICTORY GARDENS"

By Carl T. Sigman and William J. Ward, Jr.

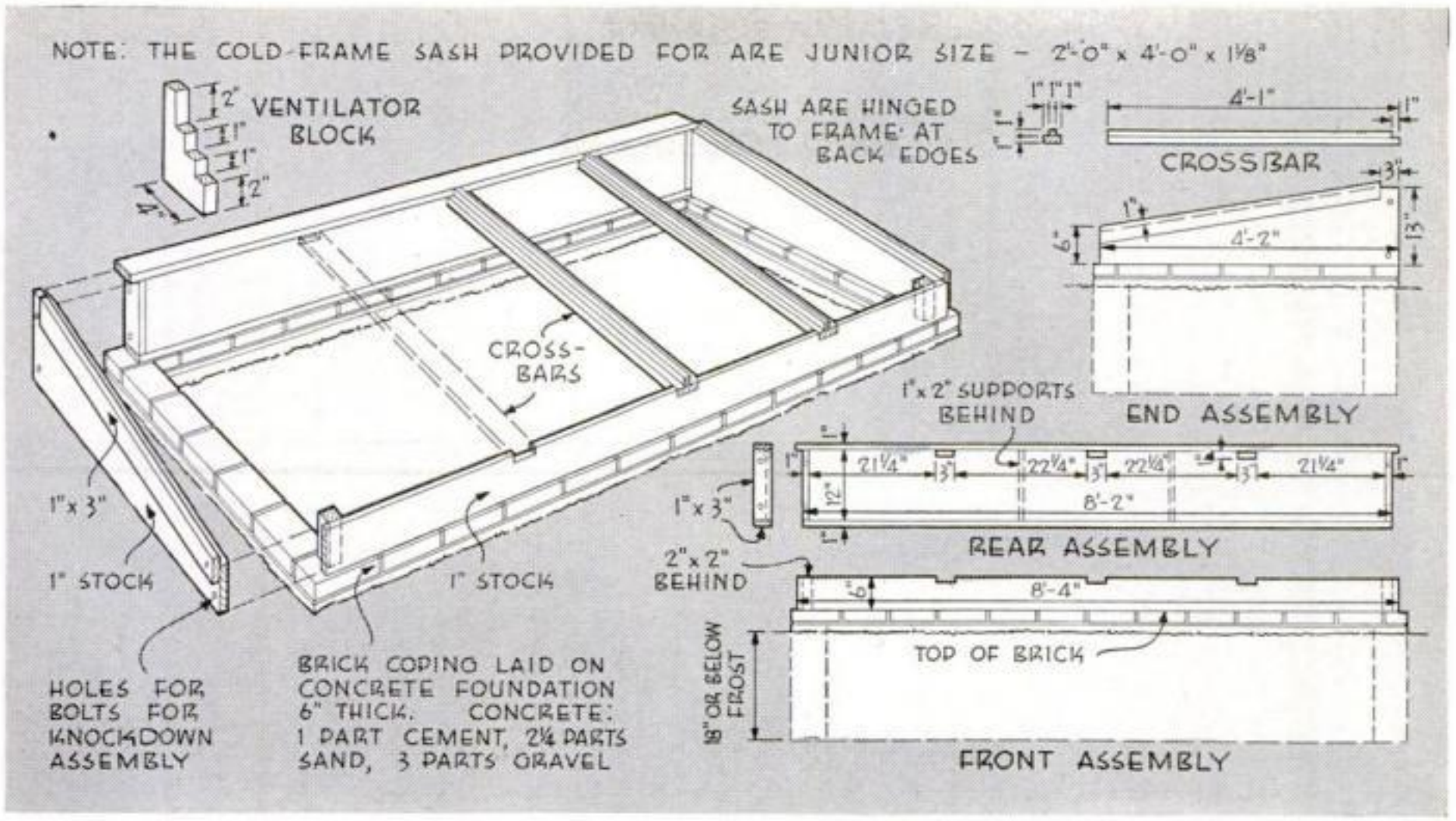
WITH the announcement of the Victory Garden Program sponsored by the Office of Civilian Defense, gardening becomes of greater importance than at any time since 1917. This country will have to make large contributions in food to the United Nations. You can help by growing and preserving as many of your own fruits and vegetables as possible.

The successful gardener knows the value of good equipment. In both the home and the community garden, the useful accessories described on these pages will contribute much to the raising of better, more abundant crops.

If you have only a limited amount of ground, you may have to get two or even three yields a season out of every square foot of space. This requires the raising of seedlings in forcing frames and flats so that new plants will be ready to set out as soon as a crop is harvested. Gardening thus begins in the cold frame, hotbed, and seed flats while frost is still in the ground, and these aids come into use again in late fall to extend the growing season several weeks after the first frost.

From spring to fall, however, ordinary cold frames occupy valuable garden space that might be put to other uses. The cold frame illustrated is made in four sections so that it may be taken apart when warm weather comes and stored out of the way. It has been designed for 2′ by 4′ sash made especially for the amateur gardener. If this size is not obtainable in your locality, you can build the cold frame to take standard 3′ by 6′ sash instead. As it will be exposed to weather, it should be made of some such wood as cypress, redwood, or cedar.

Select a sheltered place facing south and protected from chilling winds, if possible, by a hedge or board fence. Additional protection will be needed on cold nights in early spring. For this purpose, quilted burlap



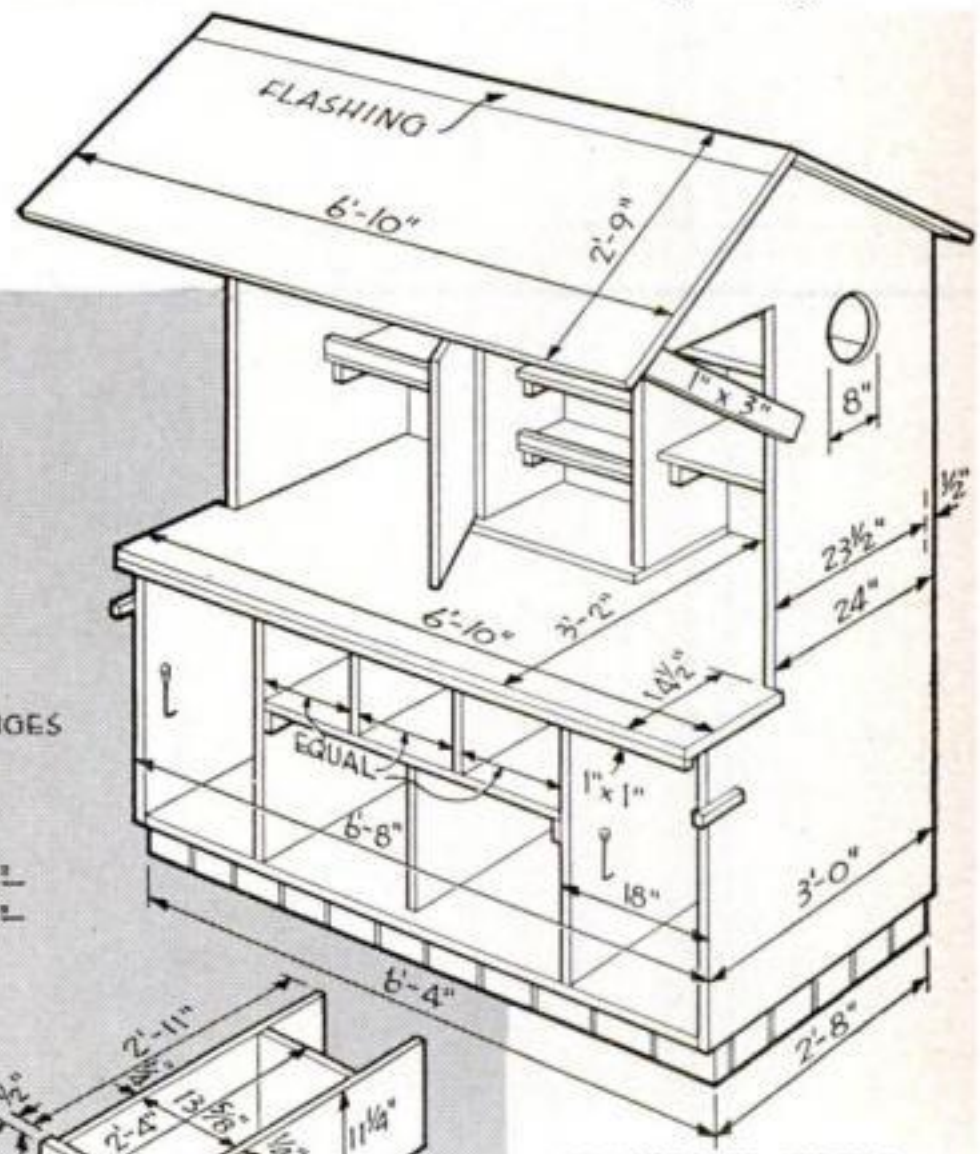
The parts are bolted together on a brick coping. Use cypress or another wood that withstands weathering

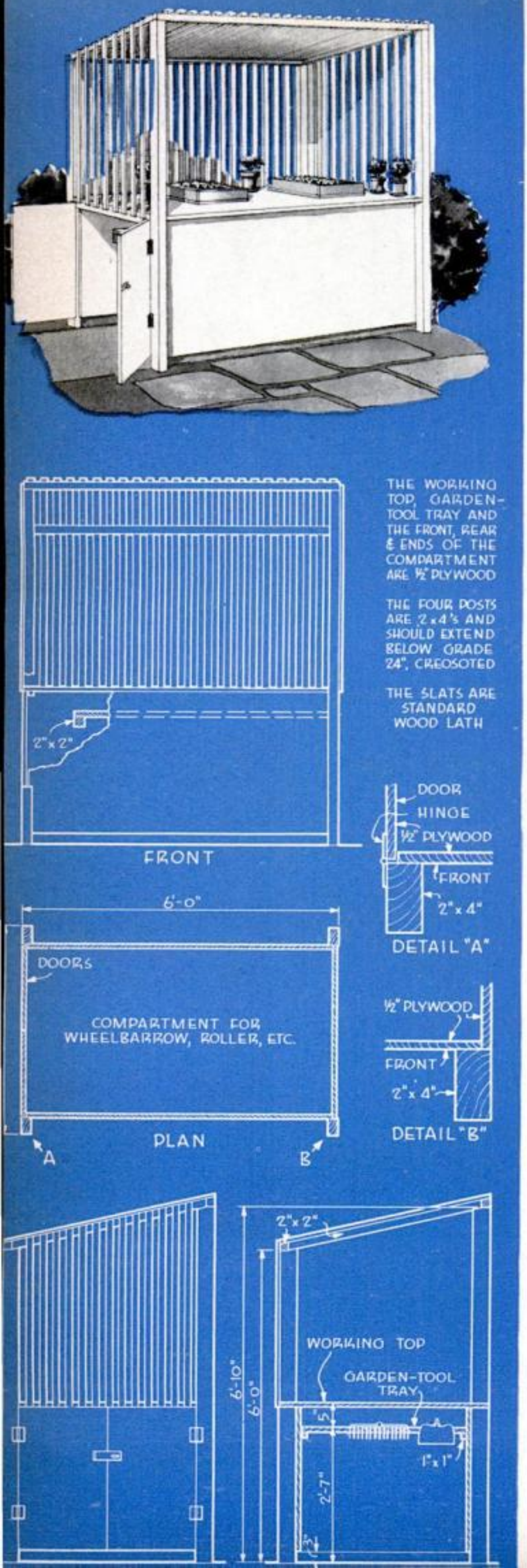
mats and shutters to hold them in place may be purchased.

The difference between a cold frame and a hotbed is that the latter is artificially heated by electricity, by steam, hot-water, or warm-air pipes laid in the subsoil, or by the heat produced by the fermentation of fresh horse manure. However, thermostatically controlled electric heaters are so satisfactory that other means are rarely used today. A hotbed can be started earlier in the spring and continued later in the fall. By partitioning off part of this cold frame and installing a heating device you can have one in the same bed.

On our Home and Workshop "cover" and below is illustrated a gardener's workbench. In this he may store pots and flats, fertilizers and other materials for potting as

This potting bench provides a working surface as well as storage space for many garden materials





indicated on the drawers and bins. One of the shelves has a board in front to make it a shallow bin for pebbles and shards of crockery, which all gardeners save for use in flowerpots and flats to provide drainage. Note the locked center section for small tools and the temporary storage of bulbs and seeds. There is, of course, a back to this cabinet, but the rest of the structure above the working surface may be left open if desired.

The three center drawers have extended sides that prevent them from being pulled out too far. Although fertilizers and peat moss are not costly, they must be kept dry and certainly should not be wasted during the present period of emergency. This bench has therefore been provided with a locking device that fits across the bins and drawers to keep driving rains from coming in through the handle notches.

The entire structure is supported on a framework of bricks set on edge, and overhangs this to provide toe space. The sides, working surface, partitions, and bottom are made from single sheets of ½" outdoor plywood.

Flowers and vegetables require sun, but too much is often more harmful than too little, particularly in the hardening stage between cold frame or hotbed and garden. Both sun and wind evaporate water from the soil and draw moisture from the leaves of plants by transpiration. Too great a loss of moisture may cause young plants to droop and die. Seedlings in the slat house illustrated, which should face to the north, get alternate sun and shade as the sun proceeds from east to west. The lath walls also check drying winds to some extent.

What would otherwise be waste space underneath serves for the storage of tools and a wheelbarrow or roller. When only a limited amount of daylight is available for gardening, one begrudges the time necessary to carry tools back and forth from the house, and the one most needed is nearly always forgotten. In the lath house they are kept within convenient reach.

As the corner posts of the structure are sunk in the ground, they should be thoroughly impregnated with a good grade of creosote. In some places pressure-creosoted timbers of various sizes may be purchased, but where that is not possible, you can soak the posts in hot creosote for an hour or so, immersing them to a depth of at least 6" above grade. Then soak them in cold creosote, which tends to close the pores of the wood. Treated timbers cannot be painted, because the creosote bleeds even through aluminum paint.

In one of the accompanying illustrations are shown four devices to make gardening

easier. The first is a garden sled on which two baskets and various tools can be pulled from place to place. It is useful for hauling weeds and also garden produce. Ropes on both ends allow you to pull the sled in either direction. You can substitute wheels for the runners if you wish, in which case the sled becomes a useful little cart.

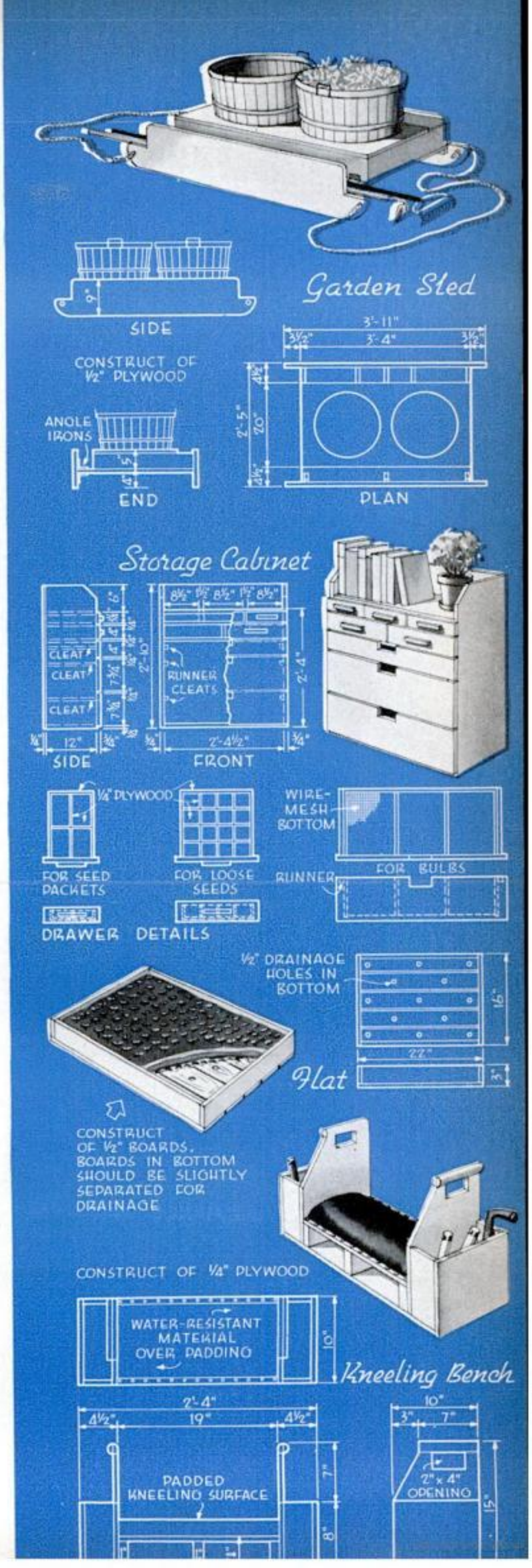
We are more likely to save seeds from our own flowers and vegetables if we have a place to keep them. Otherwise they are easily lost or, what is almost worse, the gardener finds he cannot identify them at planting time. In the storage cabinet shown, the small drawers are partitioned to hold seed envelopes. The larger drawers are for the storage of bulbs and roots, which require ventilation. These drawers are therefore made with mesh bottoms.

The humblest bit of equipment for seed propagation is the flat. It is simple to build, but as it is subjected to moisture it should be made of cypress, redwood, or cedar. To provide drainage, the floor boards are spaced a fraction of an inch apart and holes are bored in them as shown.

Having made a flat, cover the bottom with shards or pebbles and then add a layer of peat moss or compost roughage as shown in the drawing. Finally, sprinkle on a thin layer consisting of equal parts of sifted loam, humus, and sharp sand. Smooth this and tamp it lightly in place. Little or no fertilizer is necessary because flats are used only for propagation. The flat thus prepared should be soaked with a fine spray or saturated by immersing it to half its depth in water. It is then ready for the seeds. After planting, cover the flat with paper to exclude light, for most seeds germinate better in the dark.

Seedlings in flats can be grown in the house or set out in the cold frame, from which they may later be transferred to the lath house for hardening before they are finally transplanted into the garden. However, they may instead be pricked out, as it is called, from the flat into the cold frame as soon as the true leaves appear. So much time and so much higher a percentage of yield is gained from propagation in flats, that they are almost essential to good gardening.

The gardener is on his knees much of the time transplanting, weeding, and applying fertilizer. However much he loves the work, his back and knees ache just the same. The kneeling bench illustrated is padded and has side pockets for dibble, fork, trowel, bulbs, and roots so that everything is convenient as the gardener moves from bed to bed. The two handle grips make it easier to rise from the bench and also serve for moving the bench about.



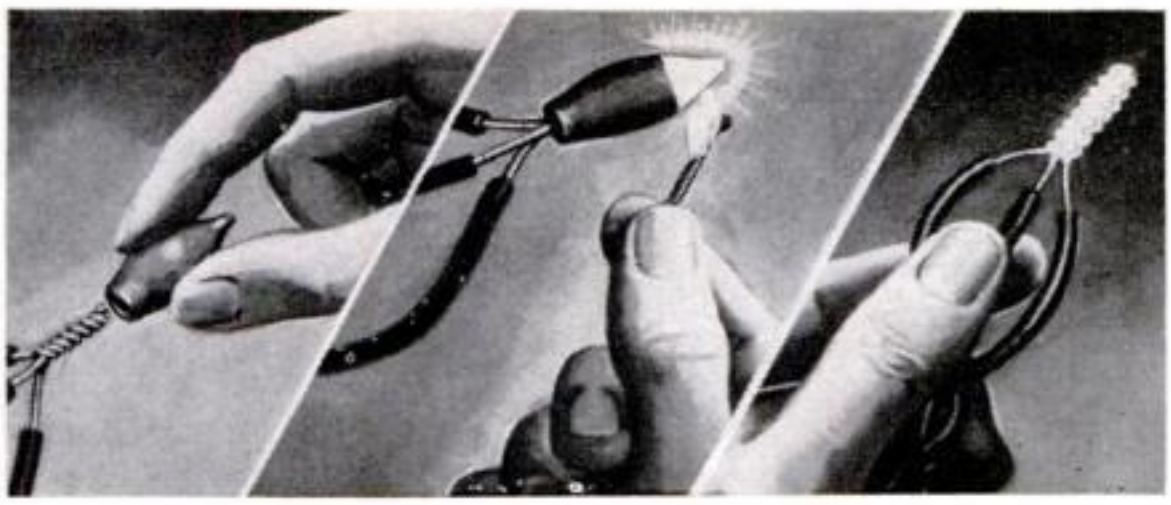
IDEAS for HOME OWNERS

INSULATION JACKETS of glass fiber can be obtained for uninsulated range boilers and hot-water tanks. Made for cylindrical boilers of 30- and 40-gal. capacity, they can be installed without disconnecting pipes and will go far toward preventing waste of heat. Cement and other needed materials come with the jackets.

PAINTBRUSH CLEANING without fuss is possible with a new cleaning fluid, can, and rack that will care for from two to five brushes at once. Brushes are hung on the rack for several hours with the bristles immersed, and different paints can be removed at one time. The fluid can be reused. Refills are available.

NEW PAINT CAN BE APPLIED directly on old without first sandpapering the surface when a small amount of a new bonding agent is mixed with the new paint as shown below. The bonding agent is a clear liquid that dulls and slightly softens the old enamel or varnish, preparing it at the time of application so that the new coat will adhere. This minimizes the danger of leaving spots on the surface where the new finish may separate from the old paint and chip off.

REMOVAL OF OLD WALLPAPER with a scraper is made easier by the use of a new removal fluid mixed with a quantity of warm water. The solution, applied to the wall with a brush, sponge, cloth, or spray gun, penetrates even tough paper and dissolves the paste behind it. After the old paper has been stripped off, another coat of the solution should be applied to remove left-over paste and eliminate the necessity of sanding or using steel wool.

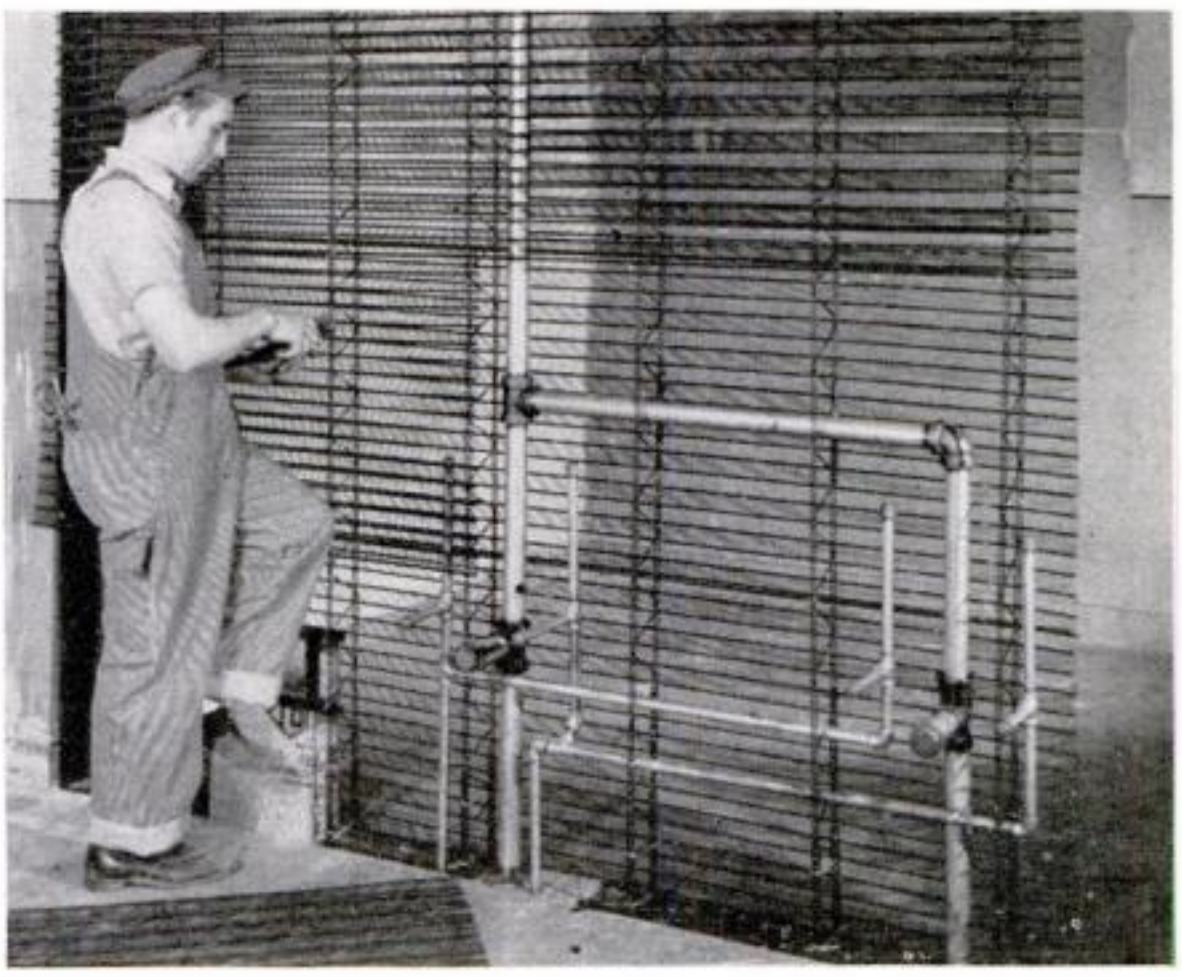


SELF-CONTAINED SOLDERING UNITS, which have a 50-50 solder and flux hermetically sealed in a waterproof heat-generating outer shell, are a convenience for obtaining quickly a well-soldered electrical connection. The wire splice is pushed into one end of the unit, which is then ignited with a match. The burning shell produces enough heat to flow the solder into the splice and is dropped off the connection when burned out. This simplified method does away with the necessity of using a soldering iron or torch on many types of electrical jobs, and is especially adapted for working overhead or in close quarters.

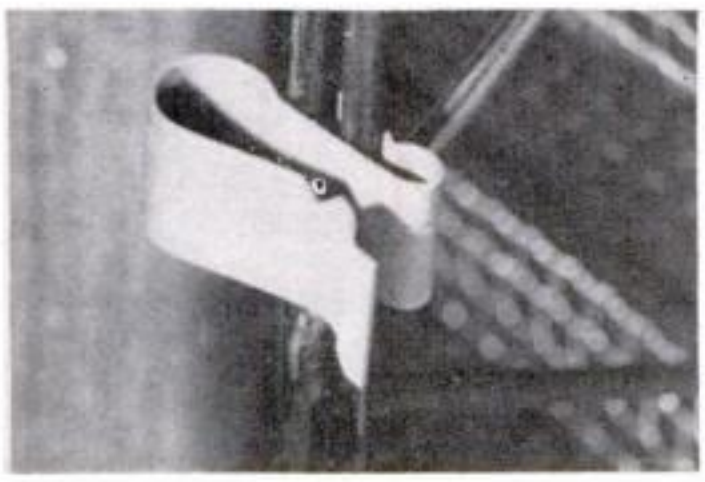
SHAPED TO FIT around a cartridge-type fuse and to give a firm grip for thumb and finger, the little tool below will be found handy for pulling fuses from tight clips or crowded panels. It is made of a nonconducting horn fiber that is strong enough to stand a considerable amount of strain. The rounded end can be used on any cartridge fuse up to 13/16" in diameter.

LIGHTWEIGHT PARTITIONS that are not required to bear loads can be installed around pipes or air-conditioning and other ducts through the use of a new steel stud-and-lath process illustrated in the photographs at left and below. To fit around pipes, one side of the stud and an end of the truss member are snipped while the stud is in position and then spliced back together. Laths are attached with ties—wire for metal lathing and special shoes for composition—and the partition is ready for plastering.

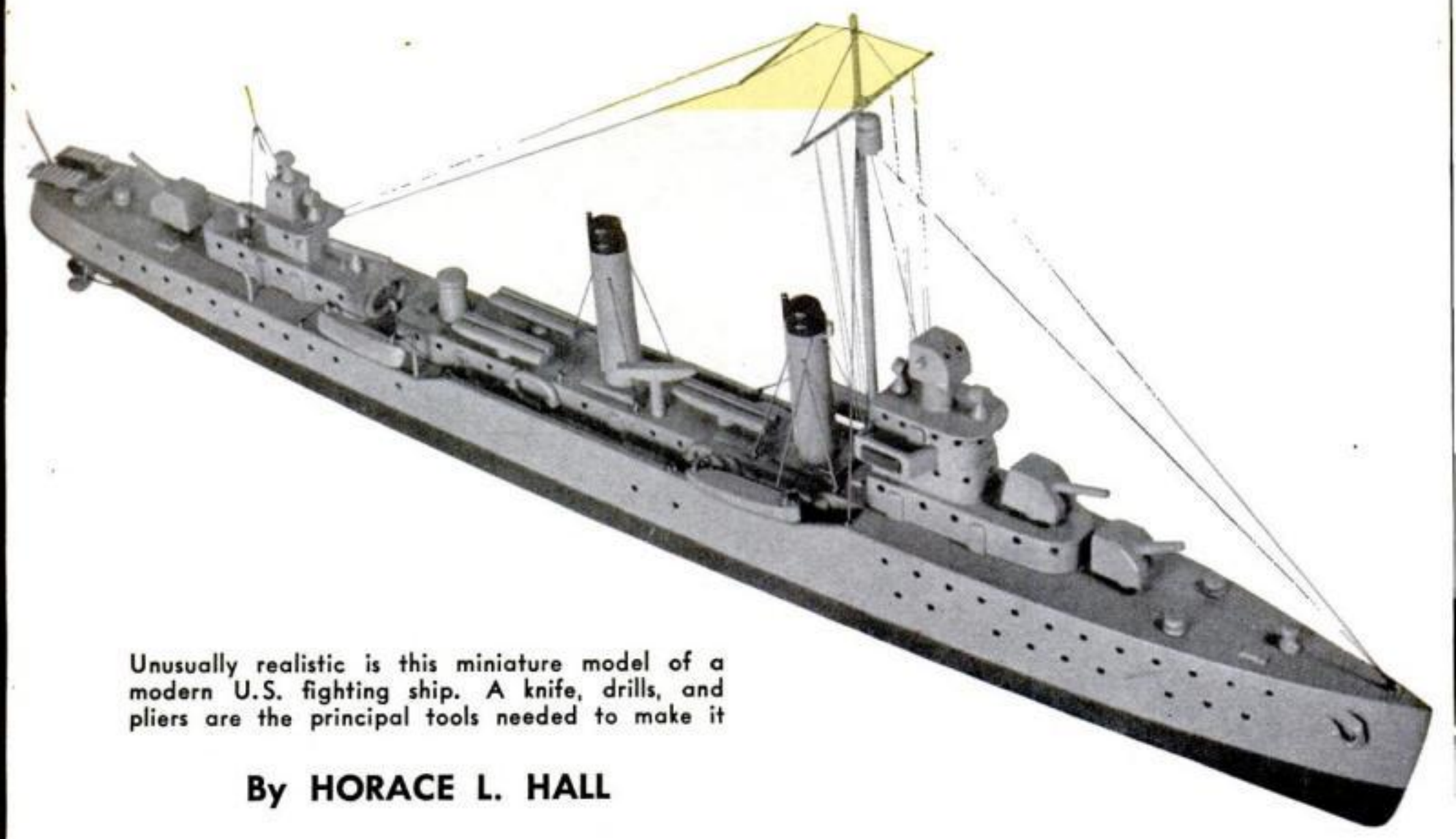
Installing a partition with steel studs and lath. The stud is being cut at the left to fit around a pipe. Below, tying on lath



Special resilient clips are used for sound deadening. Attached to the studs and tied to pencil rods which hold the lath, they produce a "floating" wall effect



DESTROYER MODEL



Unusually realistic is this miniature model of a modern U.S. fighting ship. A knife, drills, and pliers are the principal tools needed to make it

By HORACE L. HALL

HERE'S a miniature destroyer model that is right abreast of today's headlines. It represents a class of twenty-four U. S. Navy ships commissioned in 1940 and 1941, all very similar to each other. Many famous names* are included in the list, among them the *Kearny*. The model itself has been so greatly simplified and so much of the detail has been shown in a purely conventional way that it will serve for any one of these destroyers; you may therefore name it to suit yourself.

Few tools are needed to build it: a pocketknife, an oilstone, a pin vise or a hand drill with a chuck that will take No. 65 to No. 80 drills, tweezers, a 4" file, wire-cutting pliers, and small round-nose pliers. A very fine saw is useful, but not indispensable. Coarse, medium, and fine sandpaper is necessary. It is a good idea to cut the sandpaper into strips and glue it to scrap pieces of wood.

Mark the side and deck profiles of the hull on a block 1¼" by 1¼" by 12¾", and saw or whittle this to form a properly shaped blank. Then make cardboard templates of the five cross sections. Use these as a guide in shaping the hull with knife and sandpaper. Finally, smooth the hull all over, first with coarse, then with fine sandpaper. Cut out the skeg, glue it on, and pin the rudder in place.

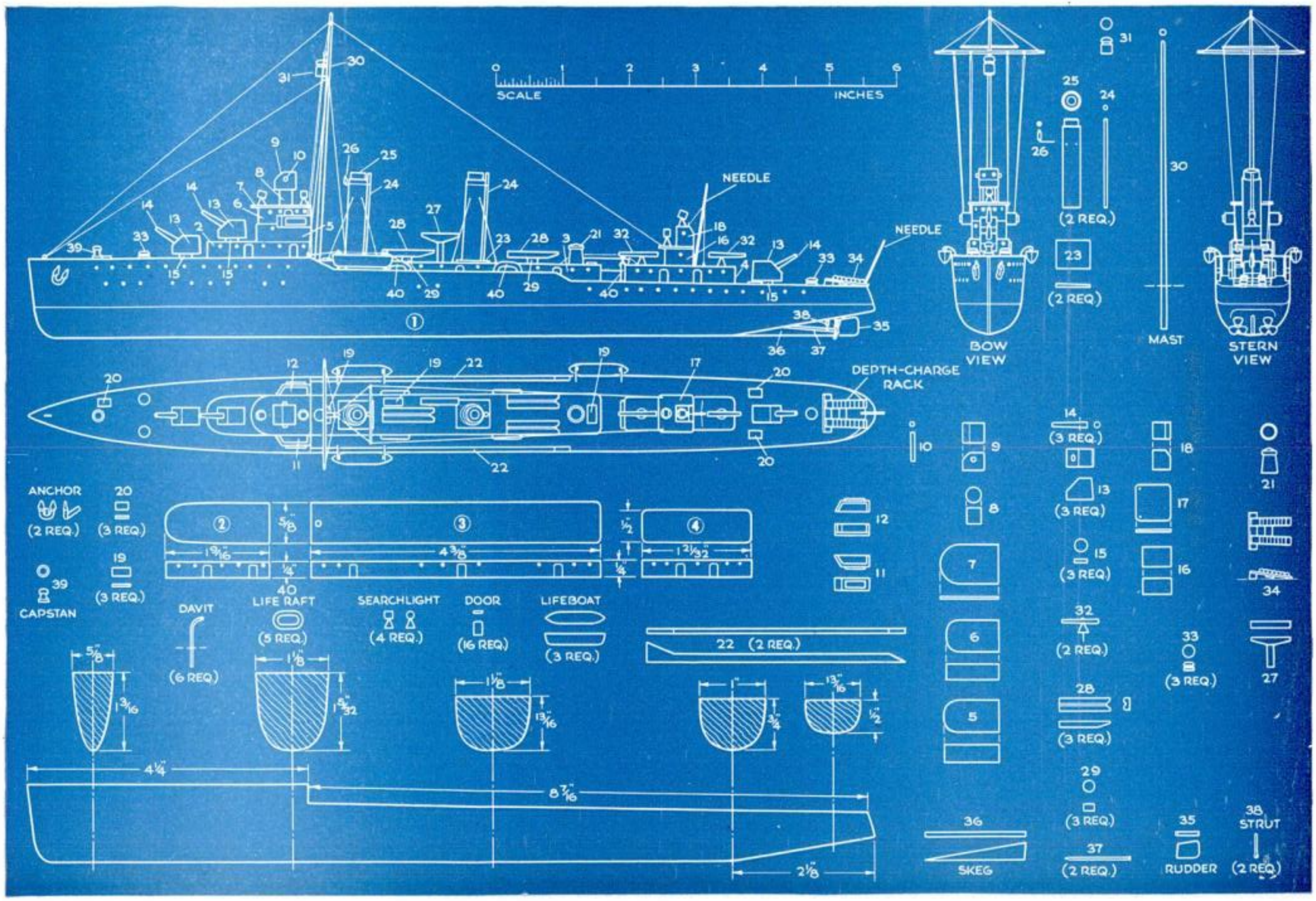
The hull is now given two coats of thin shellac. After this is dry, you can drill the small ports. The shellac will prevent the wood from splintering around the holes.

The deck houses are shaped with knife and sandpaper. Cut the doors and hatch covers from thin wood and glue them in place. The bridge and pilot-house roof are also of thin wood. Give all these parts a coat of shellac except where glue is to be applied, because glue holds better on bare wood. Assemble all these parts.

It is fine detail that makes a model interesting and is the most fascinating part of the work. If you have a small lathe or a power-driven chuck, you can use it to advantage in making the guns and other round parts. Even a hand drill clamped in a vise and fitted with an improvised tool rest will work wonders. Lacking all these, you can make your pocketknife do yeoman's service.

The guns are made by sanding 1/16" dowel to the required taper and cutting it to length. Be sure to make the guns long enough to allow for mounting. Whittle the turrets to size and drill a hole in each at the proper angle for the barrel. Thin slices of

*The twenty-four destroyers are often referred to as the *Mayo* class and are listed as follows: 421, *Benson;* 422, *Mayo;* 423, *Gleaves;* 424, *Niblack;* 425, *Madison;* 426, *Lansdale;* 427, *Hilary P. Jones;* 428, *Charles F. Hughes;* 429, *Livermore;* 430, *Eberle;* 431, *Plunkett;* 432, *Kearny;* 433, *Gwin;* 434, *Meredith;* 435, *Grayson;* 436, *Monssen;* 437, *Woolsey;* 438, *Ludlow;* 439, *Edison;* 440, *Ericsson;* 441, *Wilkes;* 442, *Nicholson;* 443, *Swanson;* 444, *Ingraham.*



LIST OF MATERIALS

White pine, basswood, or balsa

Dimensions	Parts
1¼ x 1¼ x 12¾	hull (1)
¼ x ⅝ x 9½	deck houses 2, 3, 4 and superstructures 6,16,18
1/32 x ⅝ x 6	7, 11, 12, 17, 19, 20, 34, doors
3/32 x ⅝ x 9	22, 23, 35, 36, 27, 28, 34
3/16 x 3/16 x 3	lifeboats
9/32 x ½ x 3	5, 9, 13
1/16 dia. x 9	10, 14, 24, 32, 34, yard, antenna spreader
⅛ dia. x 9	27, 30, 32, searchlights
3/16 dia. x 2	15, 29, 31, 33, 39
¼ dia. x 1	8, 21
5/16 dia. x 3	25

Pins, thread, 1/32" dia. wire, 1/16" dia. wire, 1/32" sheet fiber, glue, shellac, black, white, and red paint.

Note: All dimensions are given in inches.

3/16" dowel form the rotary turret mounts. The three turret guns represent the main battery of this class of ship.

The barrels of the antiaircraft guns are made in the same way. One way to form the tapered bases is to sharpen a piece of dowel with the knife, then twirl it between sandpaper held in the fingers until it is brought to a true point. It is then simple to cut off a section of the desired thickness and taper. Drill a No. 75 hole through both gun and base for a small pin, which is pushed into the deck house. The searchlights are made and mounted similarly.

Cut the funnels to length from 5/16" dowel, sand them down to 9/32" diameter, and sand both ends square. Then glue on the rectangular, wedgelike bases. Carefully drill a ⅛" hole in the top of each stack, and two No. 80 holes for the guy wires, as shown in the drawings. Turn or whittle down the shoulder at the top. Glue on the steam pipe. The whistle, which goes on the forward stack, may consist of a tiny brass turning drilled through for a pin, which is bent at right angles and pushed into the funnel. If you cannot turn this part, whittle it from thin dowel *after* drilling the hole for the pin.

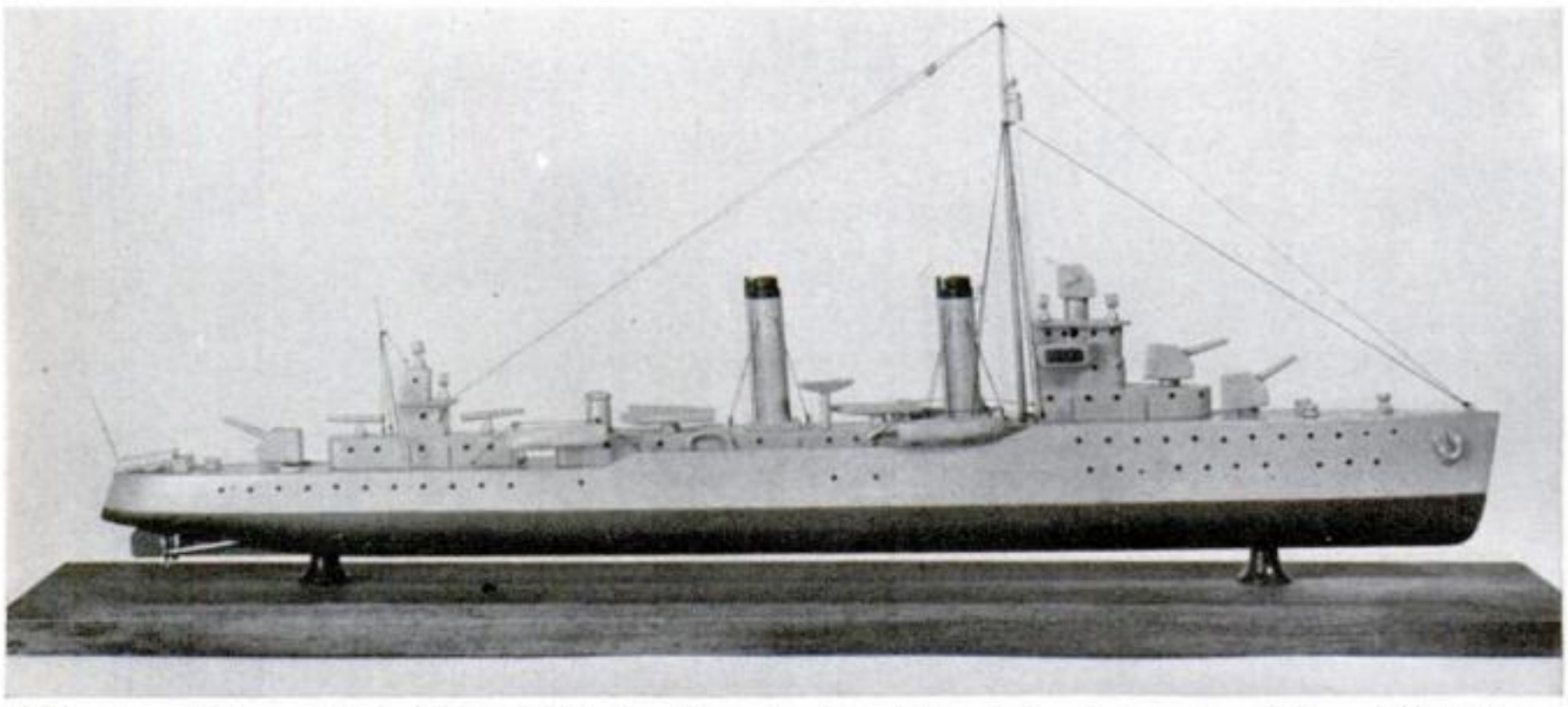
Torpedo tubes can be made by gluing together pieces of dowel or, as in the original, by scoring a shaped piece of wood down the center and rounding off the outside edges. Glue each unit to a thin slice of dowel.

The lifeboats must be carved and sanded to shape. Such parts as the crow's nest and capstan are shaped from dowel. The depth charges or "ash cans" are bits of 1/16" dowel.

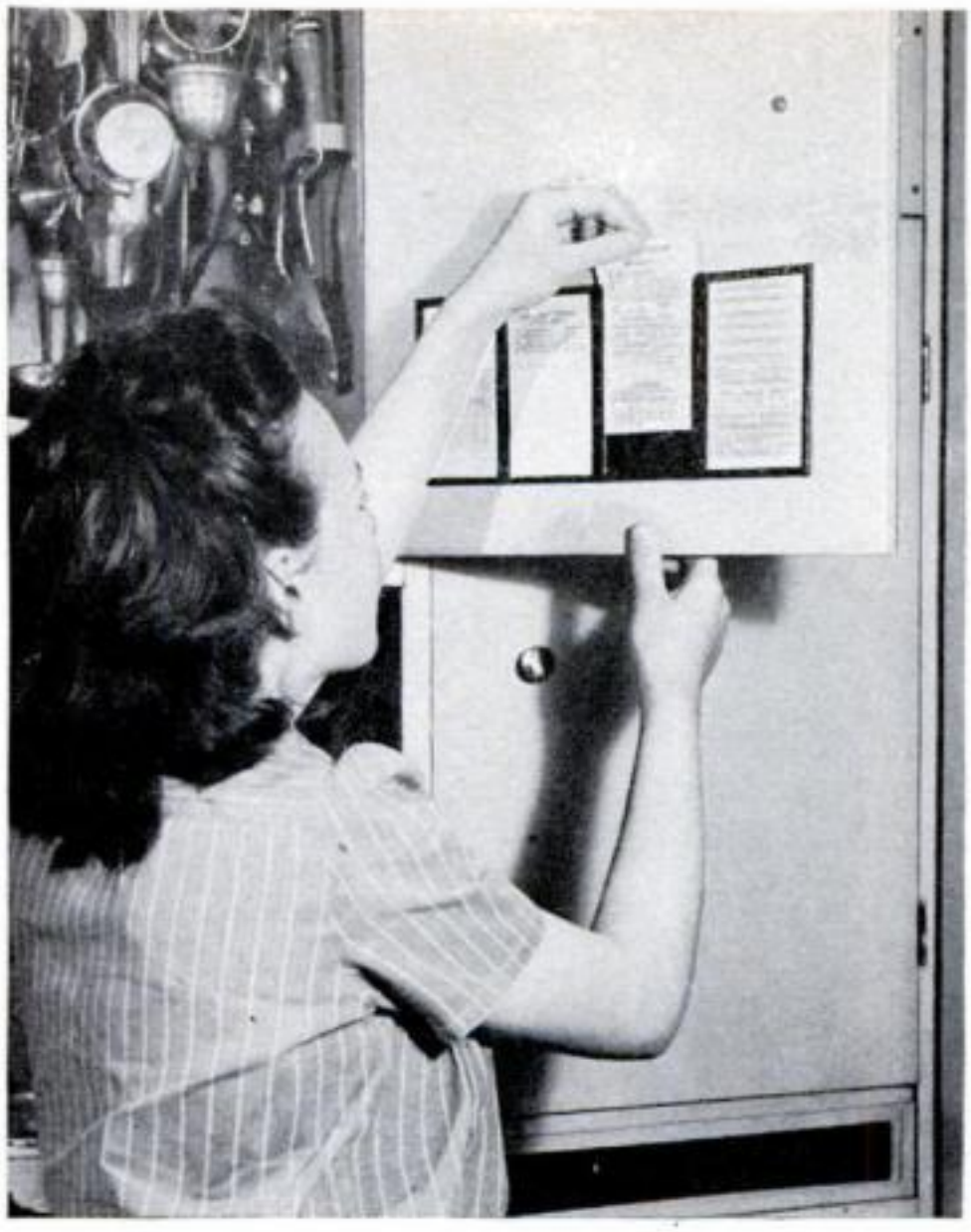
To make the tiny davits, flatten the ends of short pieces of 1/32" diameter wire and drill through the flats with a No. 75 drill. Soft 1/16" thick wire is bent, hammered flat, and filed to shape to form the anchors. Solder a pin to each, or bend one around it like a staple for fastening it to the bow. Life rafts are of the same size wire. The propellers are filed out of brass or sheet fiber; shafts are long pins, and struts are of the same material as the davits. Long pins also serve for one of the masts and the flagstaff.

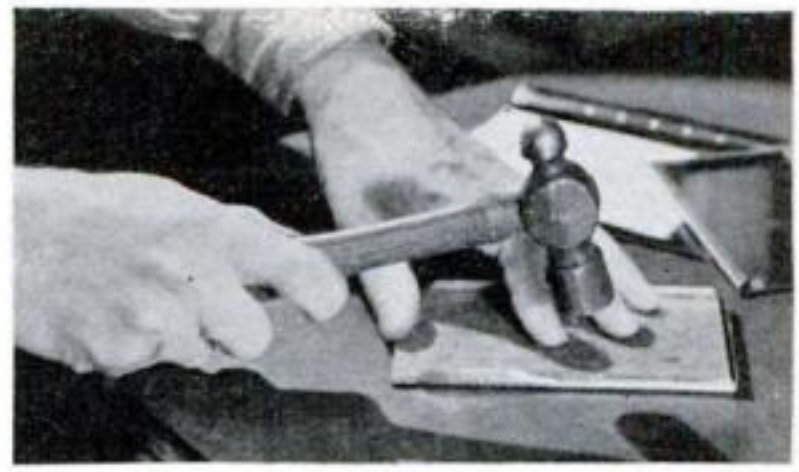
Get a tube of white and a tube of black oil paint and mix these colors to obtain an authentic Navy gray. Add some turpentine, a little japan drier, and a few drops of linseed oil. The paint should dry with an eggshell finish, neither glossy nor dull. Give the model two coats. Finally, paint the hull a grayed red below the water line.

The eyebolts can be made by bending small pins to shape, or in the same way as the davits. Thread is used for the rigging and for attaching the lifeboats.

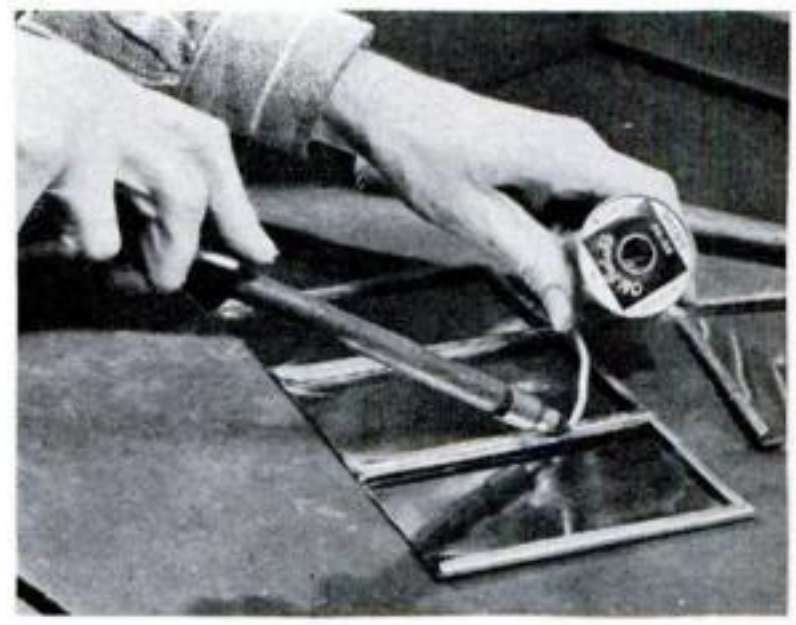


Side view of the model. Paint the hull below the water line with red, toned down by adding a little black



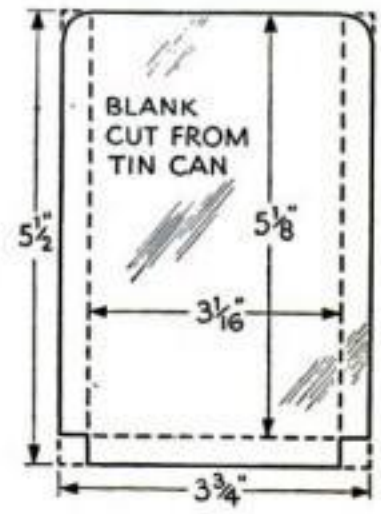


Hammer the edges of the tin over a pattern and solder a series of the clips together



Mounted on the inside of a cupboard door, three or four clips fashioned from tin cans will hold file cards containing recipes and other cooking information

Cupboard-Door Rack of Discarded Tin Cans Holds Favorite Kitchen Recipes Within Easy Reach

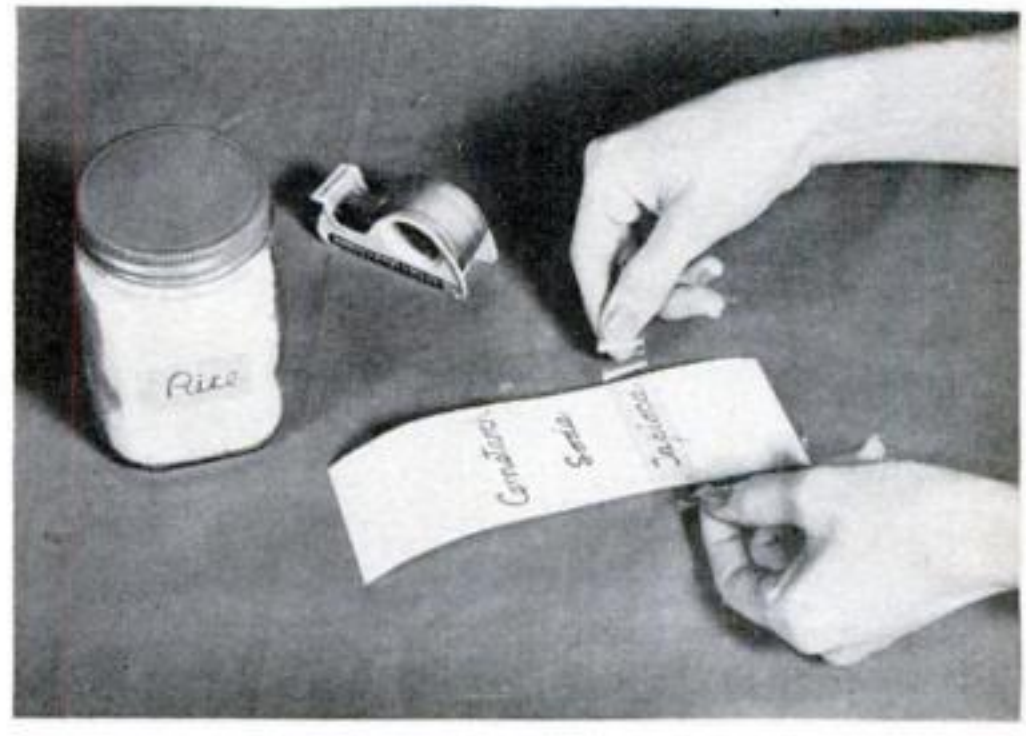


HANDY on the inside of a kitchen-cabinet door is a holder for 3″ by 5″ index cards containing favorite recipes and other frequently needed cooking information. The rack can be made from flattened tin cans.

Trim three or four pieces from the cans as shown in the diagram. Then, from ⅛″ pressed composition wood, cut a pattern 3 1/16″ by about 5¾″. Fold three edges of the tin rectangles up and over the pattern to form a clip into which file cards can be slipped. Solder the clips together for a trio or quartet, enamel them, and fasten to the door with flathead screws through countersunk holes. If the cards are graduated in size from front to rear, index markings will show.—W. B.

Waterproof Jar Labels on Cellulose Tape

LETTERED cellulose tape makes neat, waterproof labels for jars containing small items of hardware and other shop supplies, or jam, jelly, and kitchen staples. Letter ordinary paper with a soft lead pencil, then press firmly over it a piece of tape slightly longer than the width of the paper. This will transfer the lettering to the adhesive side of the strip. Pull off the tape and attach it directly to the jar.—BENJAMIN NIELSEN.



Impromptu serving is simplified with this new type of hostess tray. Guests who are not near tables can be served comfortably on the small individual lap units

Four-in-One Snack Tray

By JOSEPH ARONSON

GUESTS won't have to balance teacups on their knees if the hostess has one or more of these convenient servers. Three small lap trays, each big enough to hold a cup and saucer and a small plate besides, are kept handy in recesses under the floor of the big tray.

Band-saw the two sides to shape, then dado them ⅛" deep for the ¼" thick floor. In one of these sides cut the 1" by 7" openings for the lap trays. Rip handles and cross rails to size, rabbeting the latter ¼" by ¼" for the floor, and shape them with block plane and sandpaper. Glue the floor to the rails. Assemble with ¼" dowels in the joints between the sides and the handles and cross rails.

Cut the two subrails accurately to length and glue them to the underside of the floor. If the runner strips are of solid stock, they can be glued on, but a better plan is to make them of ¼" plywood and glue them into grooves in the subrails and end rails, as suggested in the drawing.

All three small trays are alike. Assemble the sides with rabbeted butt joints around a floor of ⅛" plywood, which is dadoed ⅛" into all four of the other members. Spline-miter joints can be used all around if preferred. However, before assembling the parts, groove the sides to fit the runner strips freely. The fronts are not grooved. This permits the trays to be pushed in only until they are flush with the side of the server. Pieces of clock spring or flat spring brass screwed to the underside of the floor engage the rear edges of the trays to keep them from slipping out. One of these springs is shown in the drawings.

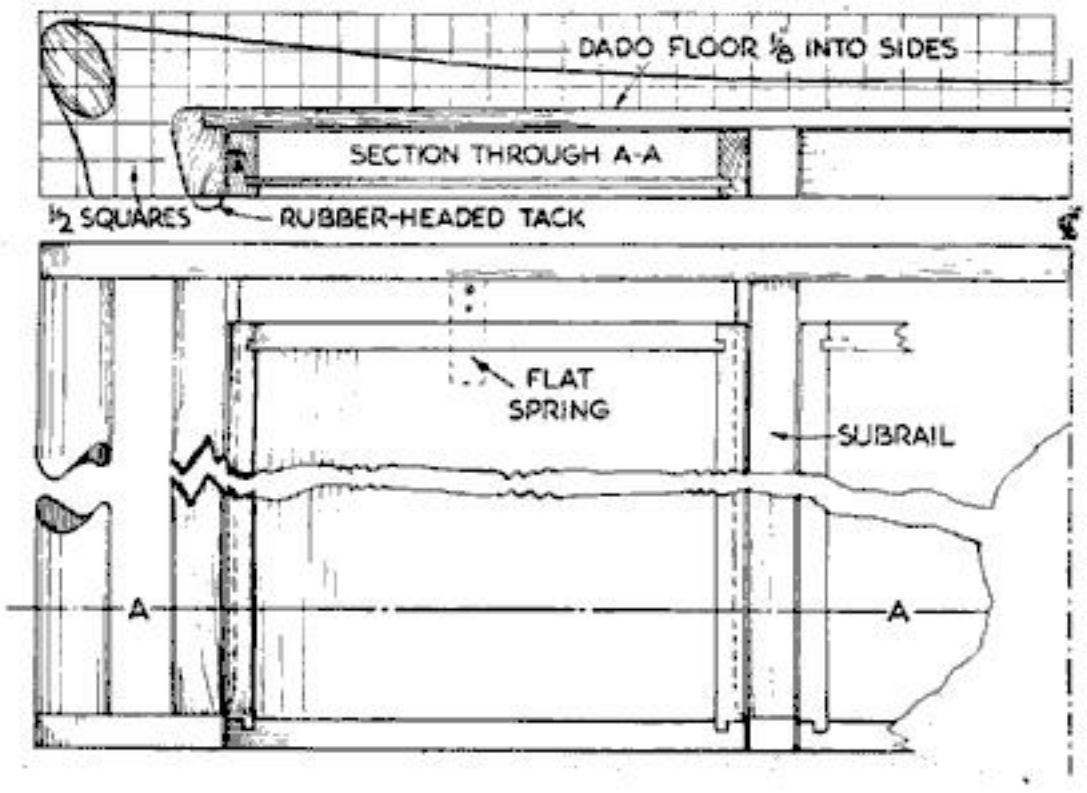
Gumwood was used for the chief parts of the tray illustrated. The rails, floor, and lap-tray bottoms were given three coats of gray lacquer. All other parts were left natural color and thoroughly waxed.

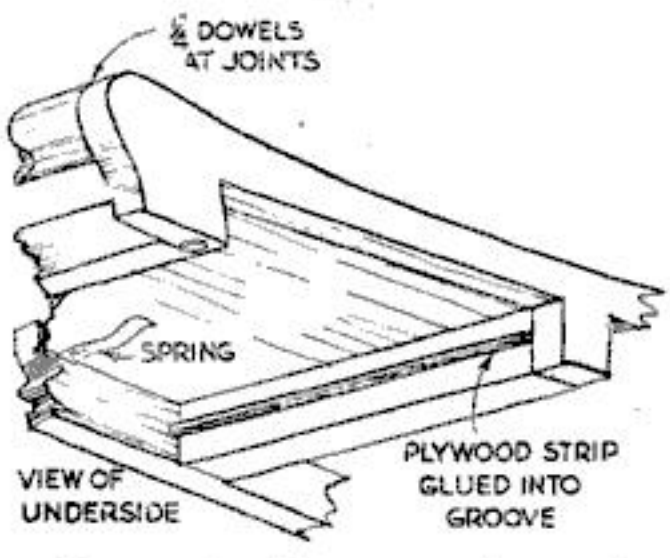
LIST OF MATERIALS

No. Pc.	Description	T.	W.	L.
2	Sides	½	2½	27½
2	Handles	⅞	1⅜	15
2	Rails	¾	1¼	15
1	Floor (plywood)	¼	15¼	23⅛
2	Subrails	⅝	1	15
6	Runner strips	3/16	¼	15
6	Lap-tray sides	⅜	1	14⅝
3	" " fronts	⅜	1	7
3	" " backs	⅜	1	6½
3	Bottoms (plywood)	⅛	6½	14⅜

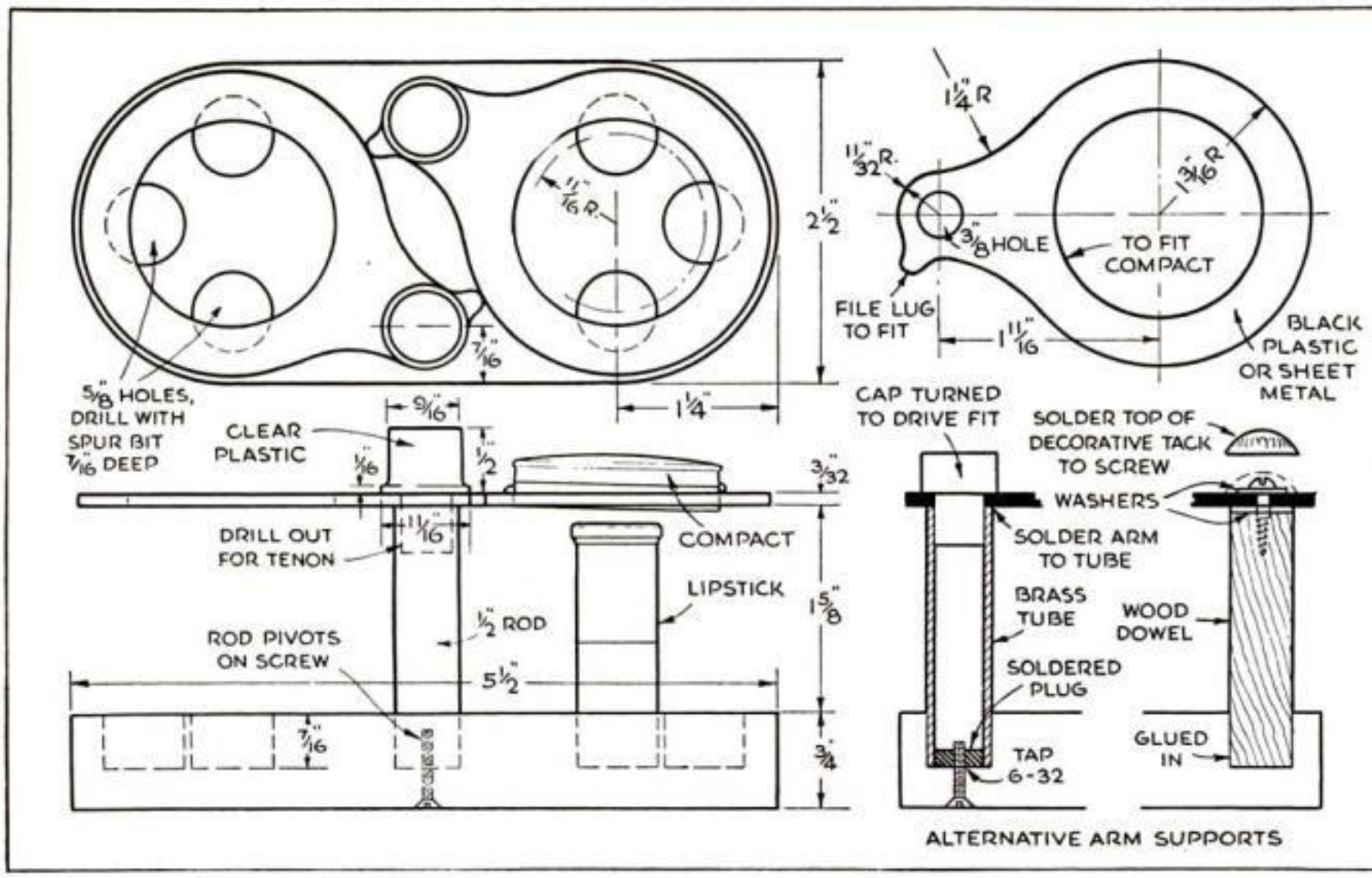
Miscellaneous: ¼" dowel, 3 flat springs, 4 rubber-headed tacks

Note: All dimensions are given in inches.





The runner strips are cut short and the tray sides, but not the front, are grooved to fit. This keeps the trays from being pushed in too far



Clocked Project

Working Time: Two Evenings

Designed by

ERNEST R. DEWALT

Cosmetic Bar

HOLDS EIGHT VARIETIES OF MAKE-UP

AN OCCASIONAL project to please the lady of the house will make her look more kindly on the home workshop. This attractive vanity-table accessory holds six lipsticks and two rouge compacts. Although the original was made of plastic, hardwood may be used instead for the base, metal tubing or wooden dowels for the uprights, and sheet metal for the compact supports.

The base is quickly shaped on a sander. Drill six uniformly deep holes to a close slip fit for the brand of lipstick preferred, using a bit that will leave a flat bottom. The two holes for the uprights must likewise be a close fit. Make the uprights long enough to support the compact holders slightly above the lipsticks. The holders can be pivoted in various ways, as shown in the drawings.

Cut holes in these holders for the compacts, which rest on their hinges and front catches. Some types of plastic can be scored and the waste tapped off; in others it will be necessary to jig-saw the holes or turn them out in the lathe. Make a trial assembly and file the lugs on both arms to bring these concentric with the ends of the base in the closed position.

Plastic parts should be smoothed with progressively finer silicon-carbide paper until all visible scratches disappear. Buffing with coarse and fine compounds on separate wheels imparts the final characteristic luster to this material. Approximate construction time, 5 hours.

Clocked Project

Average Time
6 hours

Bureau-Top Cedar Chest

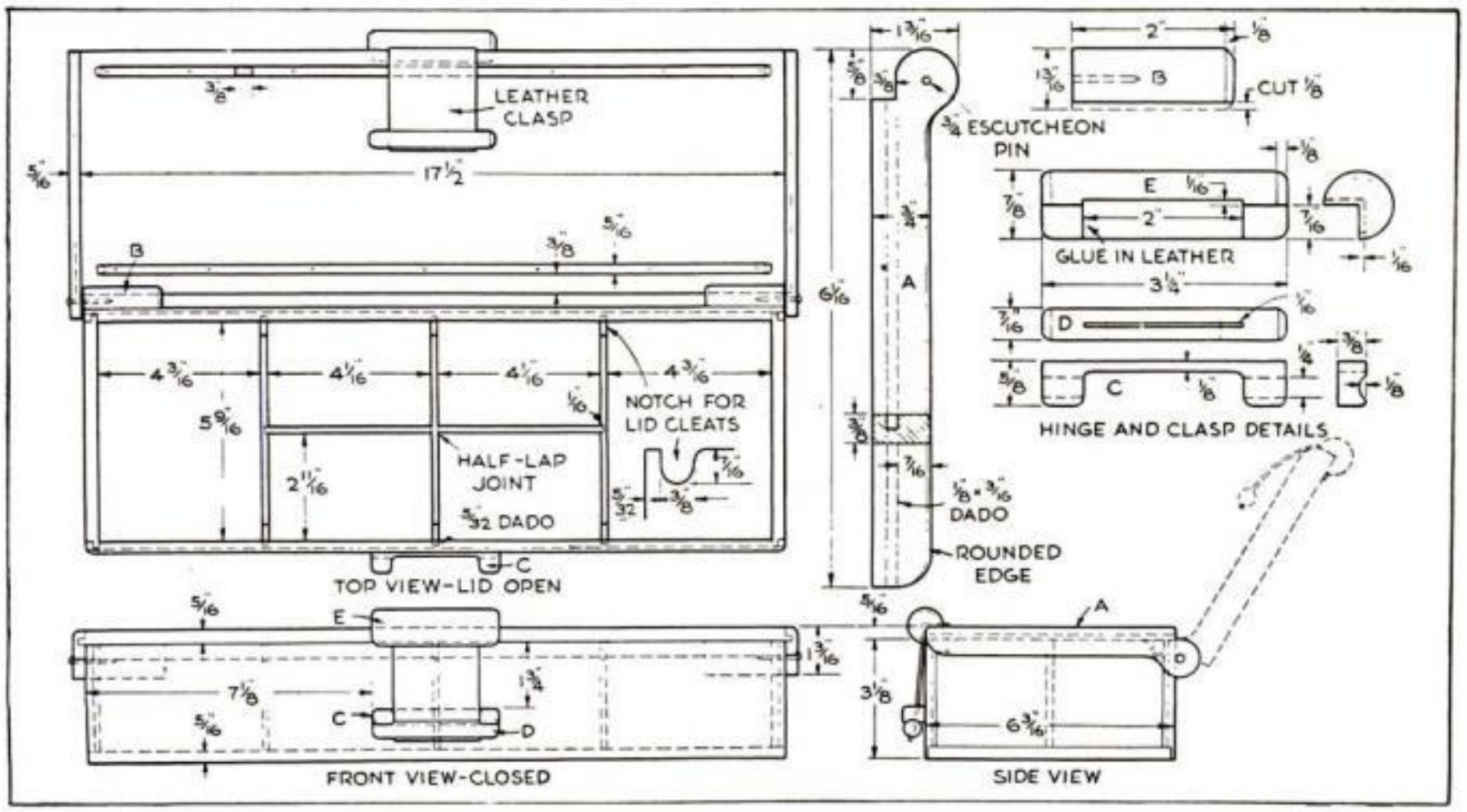
AROMATIC red cedar will foil any moths that have designs on your winter socks if you keep them in this bureau-top chest. The interior can be changed to accommodate mufflers or gloves instead if desired.

Closet-lining cedar stock 5/16" thick is the chief material used. All corners are fitted with end-dado joints, and the bottom is rabbeted into the sides and ends. The ⅛" thick partitions are dadoed into the sides, but not into the bottom, and are notched for the long lid baffles, which keep moths and dust out.

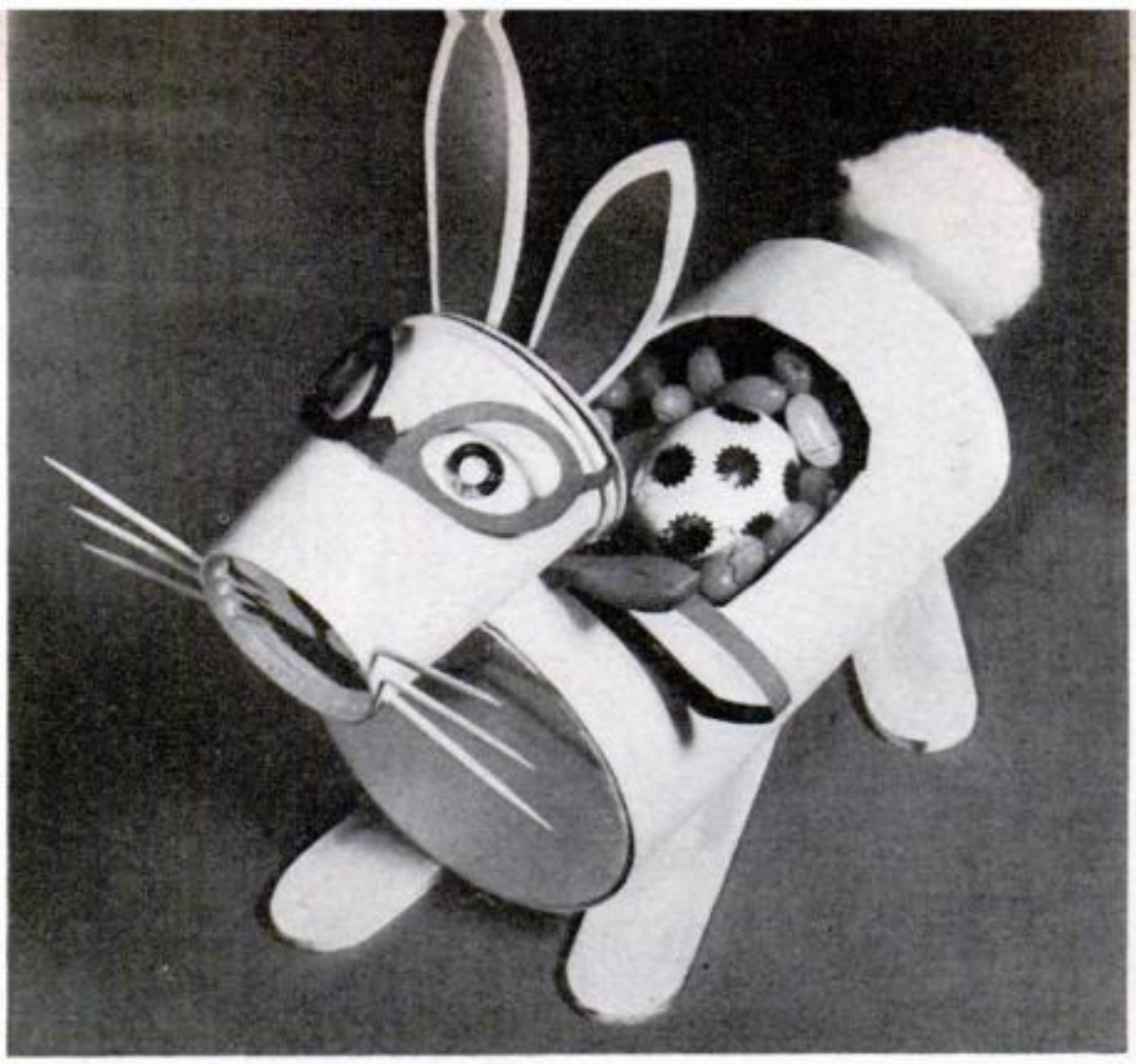
The hinge blocks *B* are turned from cedar and flattened on the side by which they are glued to the box. Chisel out a right-angle section of the turned cleat *E* to fit the edge of the lid, and recess a 2" wide portion to receive the leather flap. Slot the turned clasp piece *D* with a coping saw so that the leather can be glued in and secured with two brads. The locking cleat *C* is grooved underneath to fit *D*, and bradded and glued to the front.

Use no stain to finish the chest, but apply one coat of floor varnish diluted with an equal amount of turpentine, sand lightly when dry, and follow with two full-body coats, allowing several days between them. Varnish only the outside of the chest; no finishing material whatever should be applied to the interior.

If good-quality varnish is used, it may be rubbed down with pumice stone and oil.



Easter Novelties



A bit of cotton forms the tail on the bunny table centerpiece above. At left, in party mood, Mr. Rabbit wears a high hat. His whiskers are screen wire

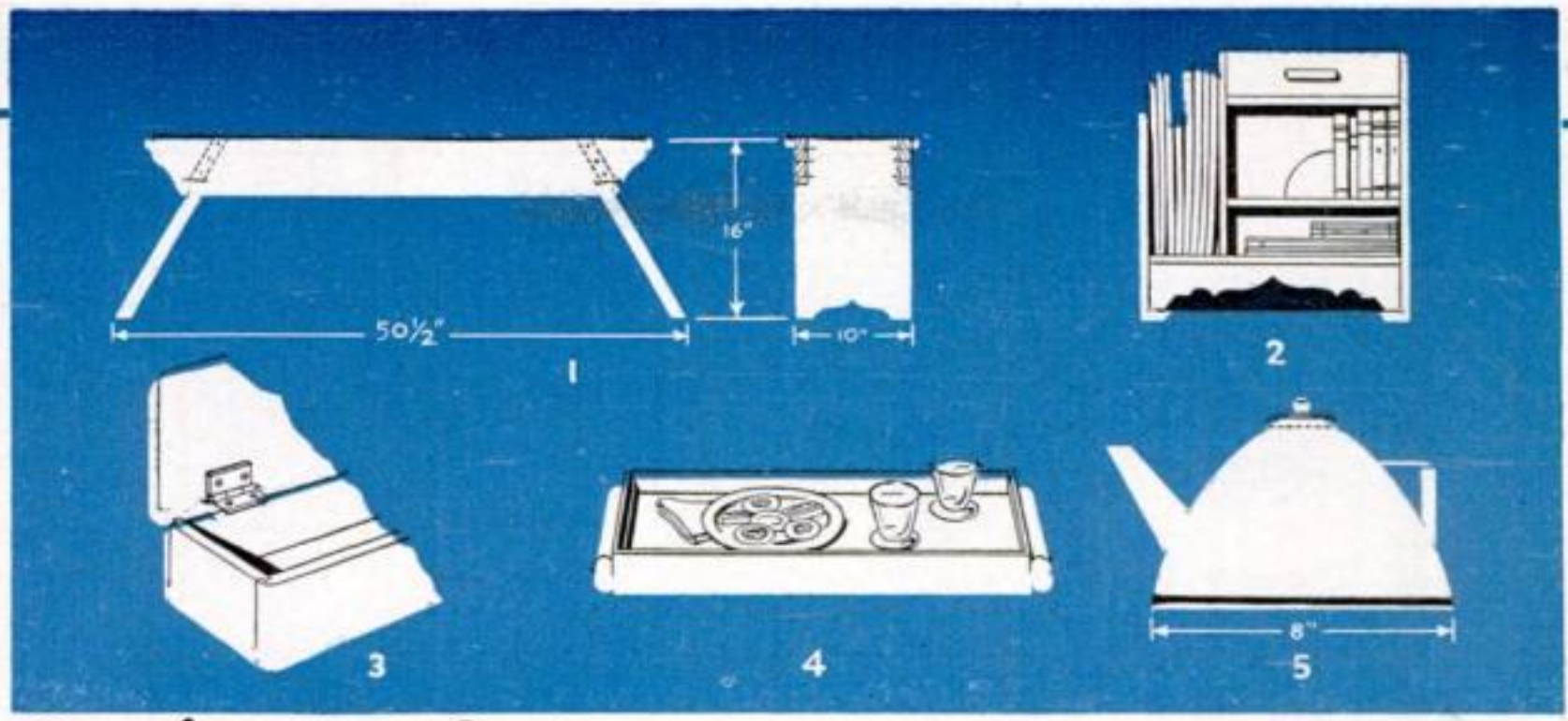
YOU'LL need eggs to make these Easter favors, so why not start now saving the shells of those used in cooking? Make a small hole in each end to blow out the contents.

Mr. Rabbit goes high-hat in the photograph at the left above, where he's perched on a jelly mold filled with candy eggs. You can, of course, use a paper baking cup instead. Dots of colored paper form the features. Wires from a bit of screening create dashing whiskers. The ears are pink paper, cemented to the egg. Roll up a piece of black paper, glue it to a paper ring, and slip the hat so formed over one ear at a rakish angle.

Easter-egg lassies such as those shown at the bottom of this page make charming party favors. Either "blown" or hard-boiled eggs may be used. A paper muffin cup and golden "curls" pulled from a copper-gauze cleaning pad are glued to the head of the first tiny miss. The demure Dutch maid has yellow yarn hair braided into pigtails, and a quaint cap cut from an old felt hat. Another baking cup forms the jaunty creation worn by our sophisticated brunette. The little lady at the extreme right wears a poke bonnet made from a paper lace doily. Features can be inked or painted in, or made of gummed dots, hearts, and the like.

An Easter-bunny centerpiece like the one at the top of this page holds plenty of candy, besides an egg or two. Use a cereal box for the body, a paper cup for the head, and toothpicks for whiskers. Cut the bow, spectacles, mouth, and insides of the ears from red paper, and the feet from thin wood such as mustard paddles. Gummed notebook reinforcements serve for eyes. Attach the head with a paper fastener, other parts with cement.—MRS. BENJAMIN NIELSEN.

Eggshells, yarn hair, and paper cups make lifelike little heads. Mount them on inverted bottle caps



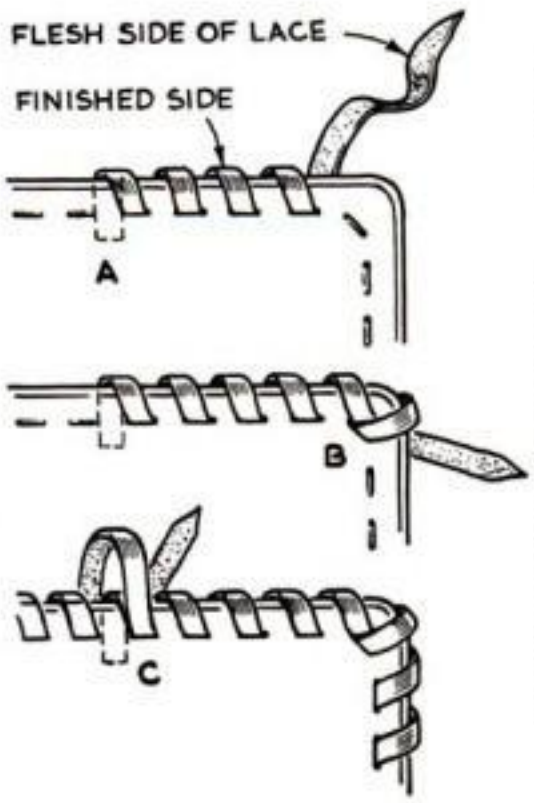
What's Wrong?

CAN YOU FIND SIX ERRORS OF DESIGN?

WOULD you construct these articles as shown, or can you detect their faults? The bench (Fig. 1), the utility shelves (Fig. 2), the box (Fig. 3), and the serving tray (Fig. 4) each have a single defect. What two faults would keep you from buying the modern teakettle in Fig. 5? To check your answers, turn the page upside down.

1. The legs are set at too great an angle, which weakens the structure and is likely to cause tripping. They should not extend beyond the ends of the seat. 2. The scroll-sawed base cut-out is not in harmony with the modern lines of the piece; it would be hard to clean under, and also easily broken. 3. No gain or recess was cut for the top leaf of the hinge, which should be flush with the inside lid surface. As shown, the lid would touch the front edge when closed, b it there would be a gap along the back ed ge. 4. The tray could not readily be lifted up by the handles, because these are set so low there is no clearance for the fingers under them. 5. (a) The small lid opening makes proper cleaning difficult. (b) The handle is too small for more than two or three fingers, and they might be burned.

EDGE LACING—WHIP STITCH [*LEATHER CRAFT—9*]



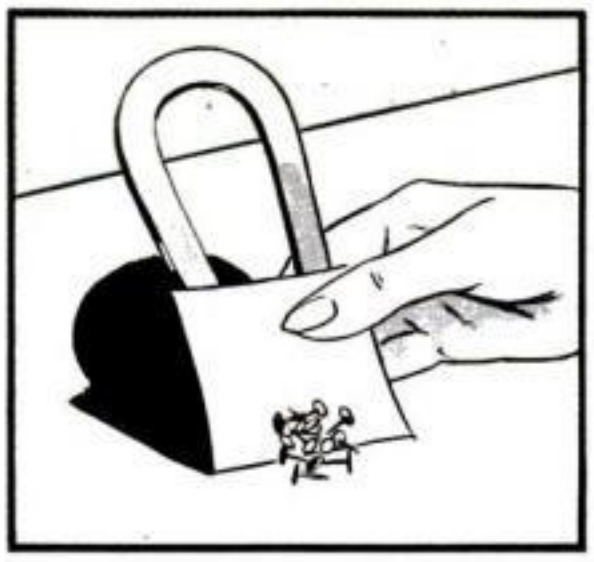
Edge lacing greatly improves the appearance of many leather articles. The simplest form of lacing is the whip stitch. All edges must be cemented, trimmed, thonged, and dyed. Use 3/32" lace for small articles, ⅛" lace for large ones.

Cement one end of a 3′ length of lace to the flesh side of the leather as at *A*. If there are two or more thicknesses, cement it between them. Point the loose end. Use an awl to open the thong slits so that the lace may be inserted easily. Holding the finished side of the work toward you, lace from left to right, drawing up all stitches with equal tension. Lace the corners as at *B*, going through the same slit twice. To join a new length, skive both ends back for ¾" and cement them together. Finish lacing by going through the first slit again, as at *C*. Put a little cement on the flesh side of the lace before tightening the last stitch, and cut off the surplus.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

KEEPING THE HOME

Steel-wool scouring pads rust and are disagreeable to use long before they wear out. It pays to cut each in half with an old pair of scissors. A half serves for a day's use and is then thrown away

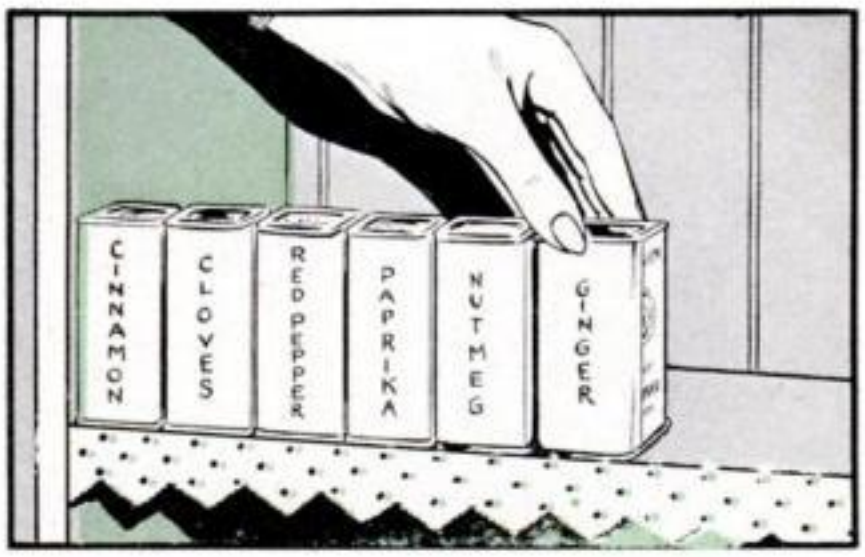


When using a magnet to pick up pins, tacks, and other sharp objects, you can quickly strip them off if you first fold a piece of thin paper over the poles. This also prevents injury to fingers

Ordinary jelly glasses inverted over young plants newly set out in the open serve as miniature hothouses, stimulating growth and protecting the young shoots from some types of insect pests

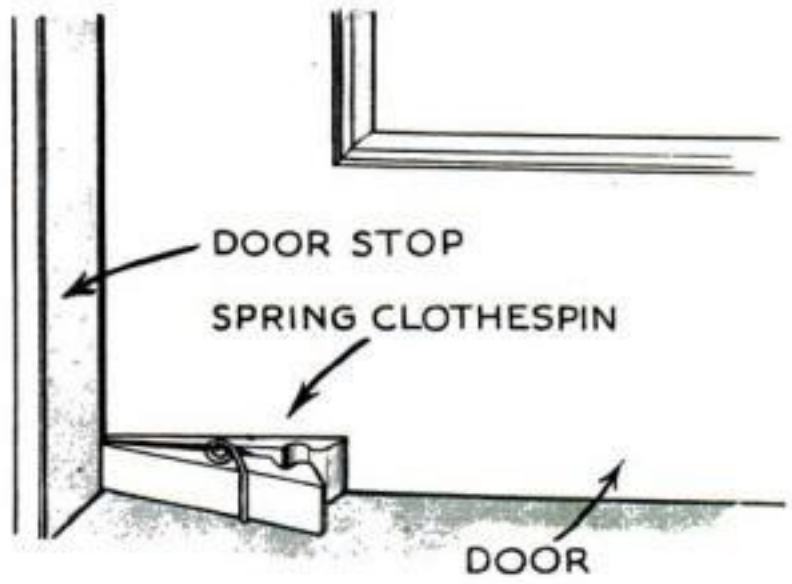
Try wiping kitchen window panes with cleansing tissues before you wash them. This will remove any grease there may be on the glass, thereby making it easier to clean and preventing smudges

A sprayer bottle intended for applying window-cleaning fluid is convenient for dampening clothes that are to be ironed. The fine spray wets them much more uniformly than ordinary sprinkling does

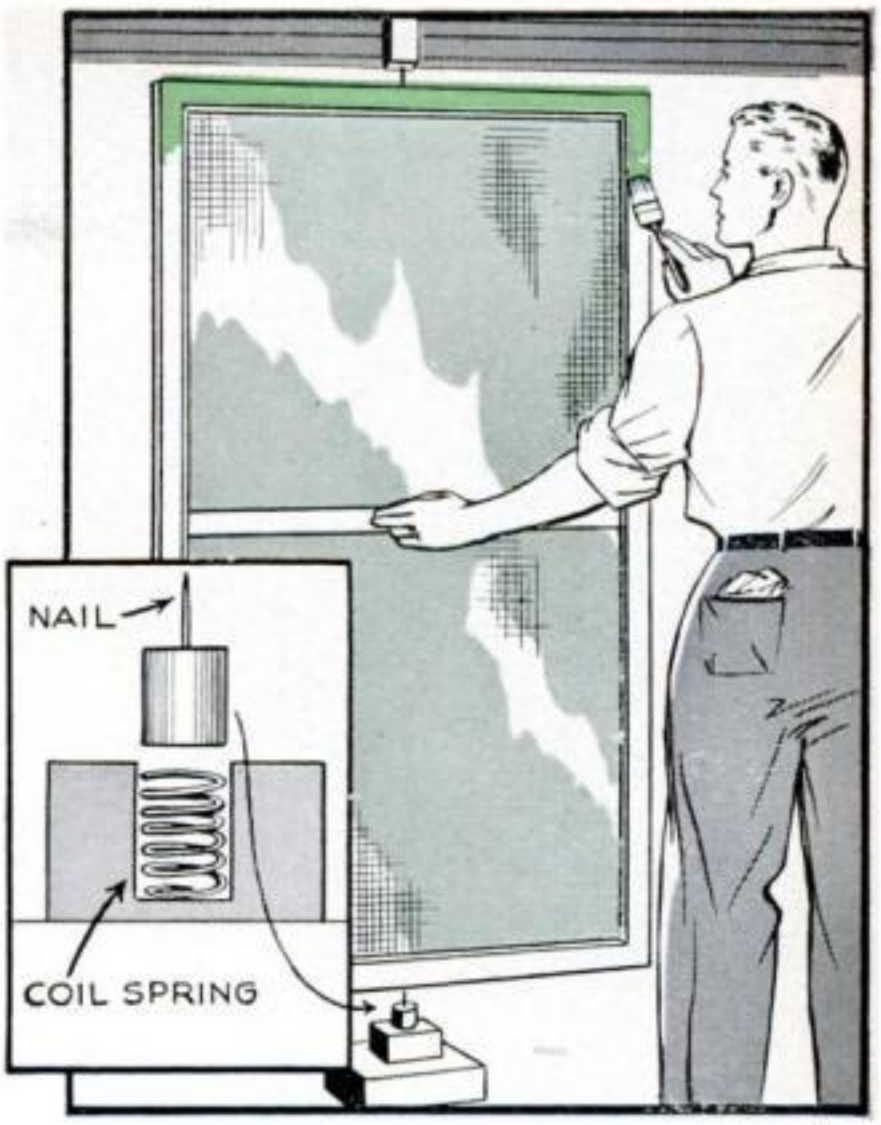


Spice cans are usually kept with the wide sides forward so that the labels are visible, but if written ones are pasted on the narrow sides, the cans may be ranged as above in less shelf space

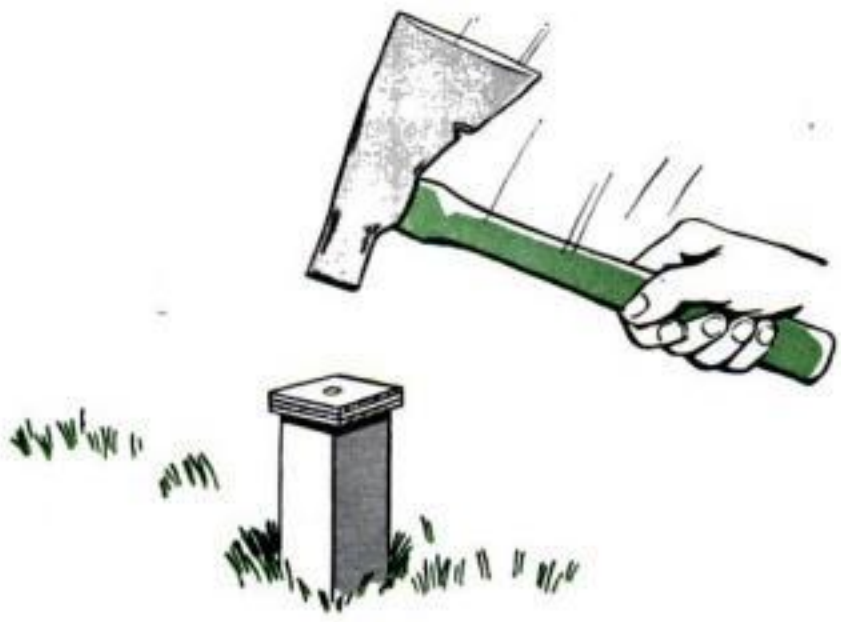
SHIPSHAPE



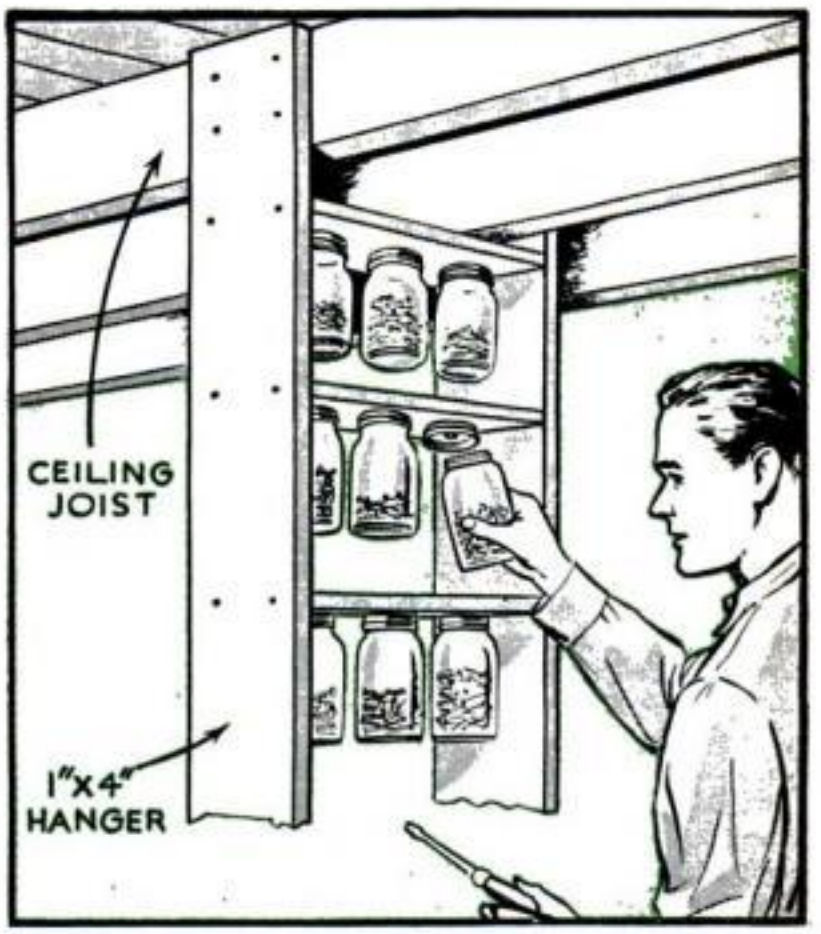
A rattling door can be temporarily silenced with a clothespin placed between it and the stop on the latch side, as above. If appearance is not important, the clothespin may be nailed or screwed on



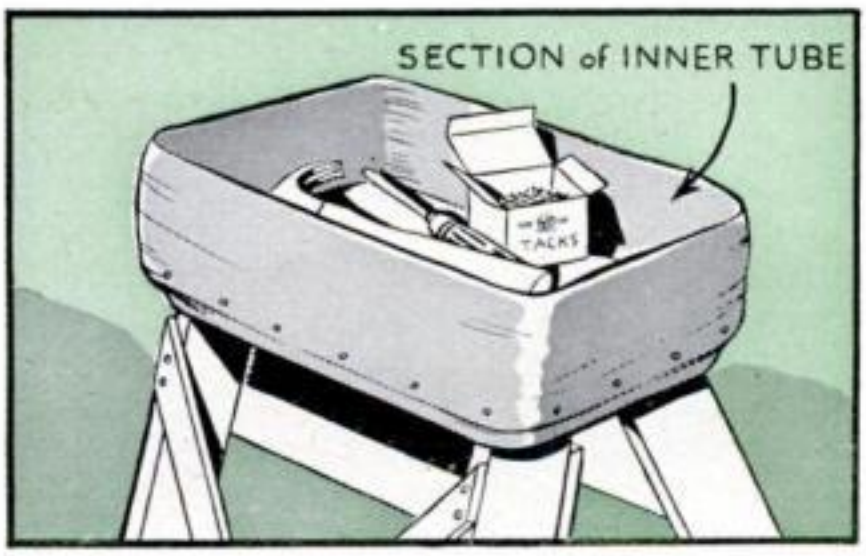
Pivoted as above, screen and sash frames are easy to paint. Drive a nail into a block and clamp it to a joist overhead; push another into a bit of broomstick to slide freely in a hole against the pressure of a spring. The screen is pushed down on the lower nail, then slipped under the upper one



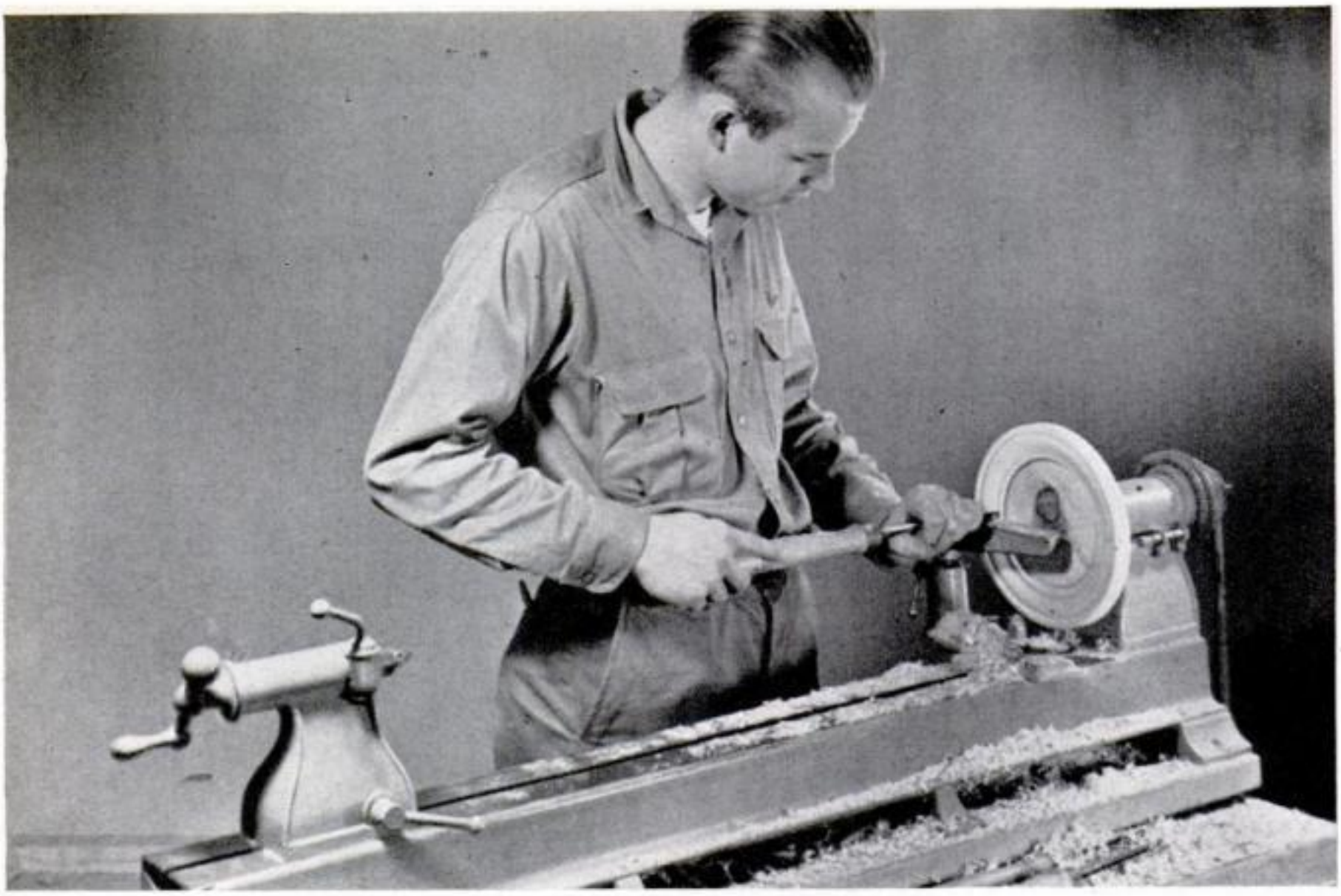
In driving stakes for ornamental fences and the like, you can protect them from unsightly marks and splintering by tacking a scrap of plywood to the top of each in turn before hammering it down



All sorts of small screws, washers, and such parts can be kept in the cellar in a rack of this kind. Nail vertical hangers to two joists, screw jar caps to the undersides of cross members, and nail these in place far enough apart to allow jars to be removed and replaced easily



To keep tools and other articles from rolling off the top of a stepladder, tack a strip of inner-tube rubber around it. As this is flexible, the top step can still be used as usual



Faceplate Turning for Creative

By EDWIN M. LOVE

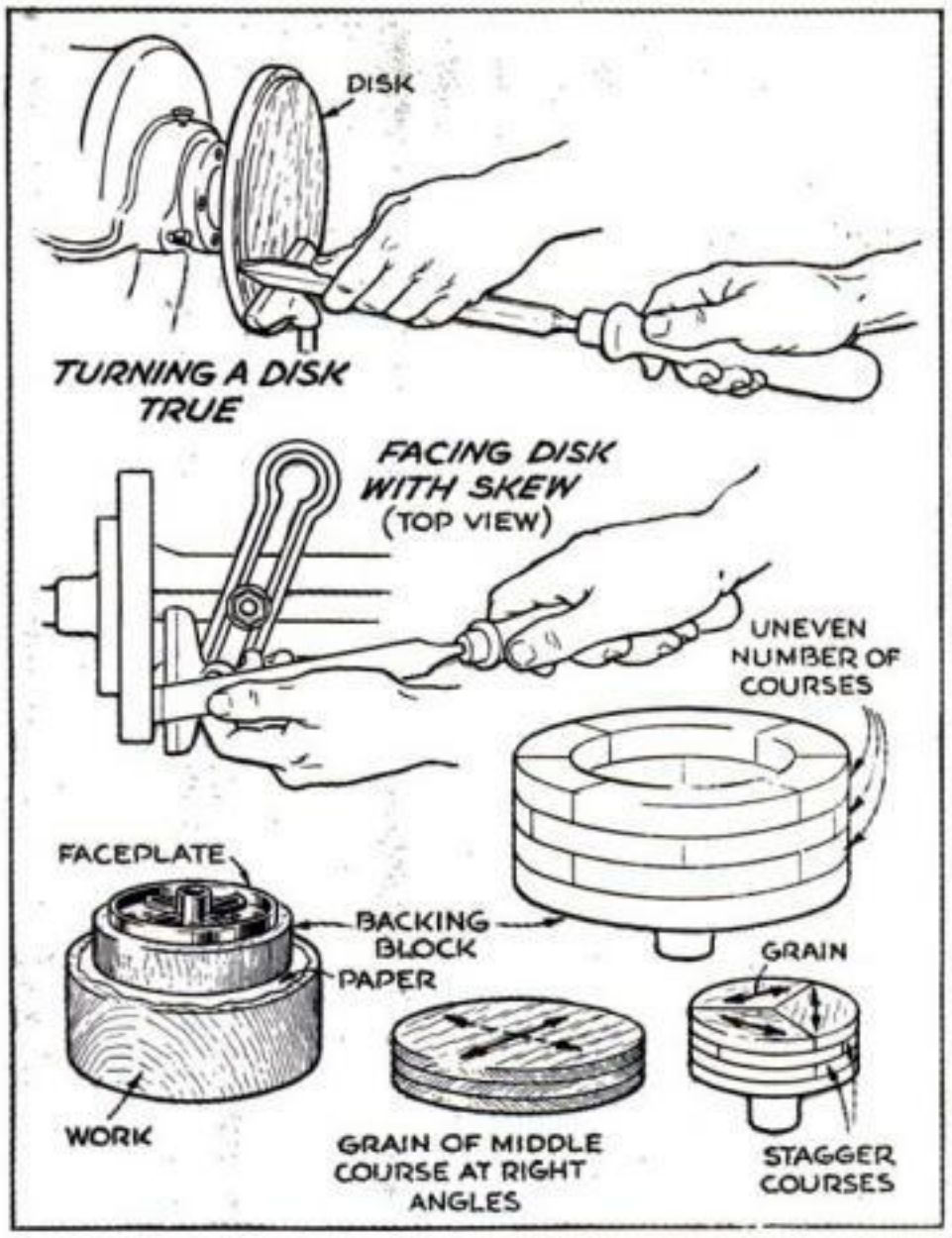
LAMP bases, ash trays, bowls, plates, circular picture frames, round boxes, and similar craftwork pieces can be made in the lathe by what is known as "faceplate turning." With suitable chucks, which are usually made on the lathe itself, perfect balls and rings can be turned. The tools are used much as in spindle turning, although it is necessary to use scraping cuts rather more often.

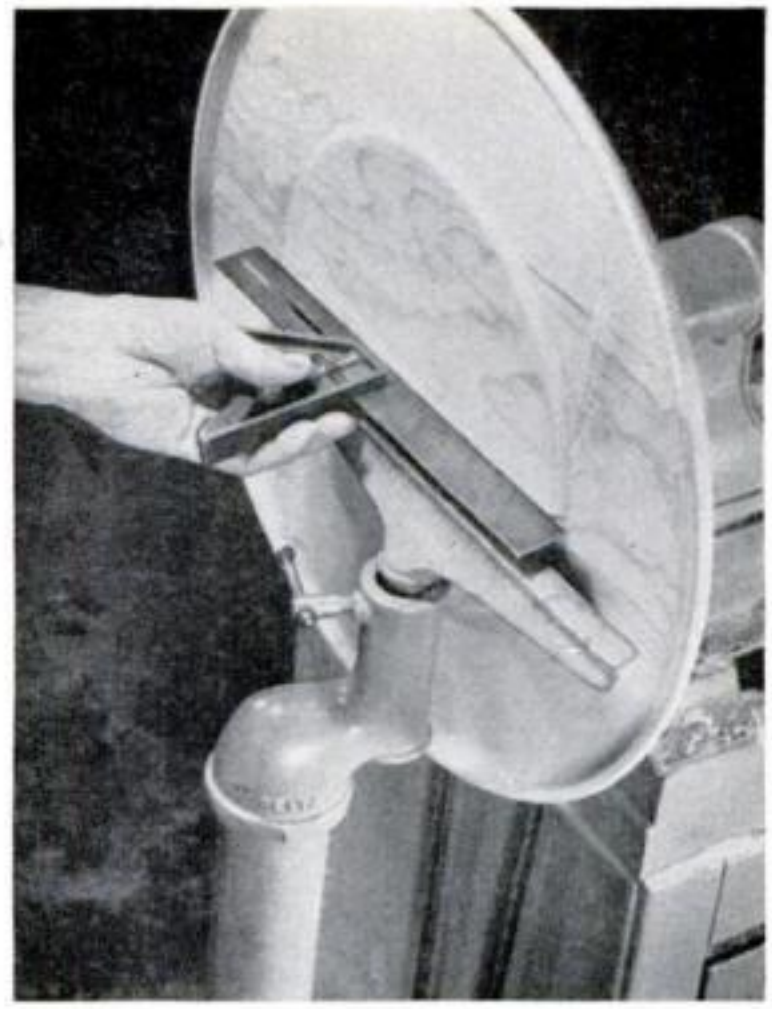
What is the first step in faceplate turning? A plain disk is the simplest form, and is often required in making chucks and ornamental pieces. Scroll- or band-saw a piece of suitable thickness to a slightly larger diameter than the disk is to be, or, if power saws are not available, cut the blank roughly octagonal. For large turnings, or to eliminate end grain and warping, glue blanks up as shown in the drawings.

Surface one side and screw the piece to a faceplate. Large blanks should be attached with four heavy wood screws, but light ones can be held on small faceplates with three, or even with one screw at the center. See that the blank is accurately centered to avoid waste and to eliminate the vibration that always results from unbalanced work. If the material is so thin that screws would penetrate the part that is to be turned, or if screw holes in the finished piece are objectionable, glue the blank to a backing block with paper between. After turning, the piece can be split off at the joint with a chisel.

With the work mounted, set the tool rest close to it, start the lathe at low speed, and cut in with a ⅛" chisel or parting tool on the largest diameter. Stop short of cutting clear through, to avoid splintering at the back. Shift the rest parallel to the edge and true up the remaining rough part with a gouge and a square-edged chisel. Thus turned true, the work can be driven at a higher speed. Reset the rest and finish off the face with the gouge and a square chisel, or the skew chisel laid flat. Test for straightness with a try square.

Can work larger than the throw of the lathe be turned? Yes, if the lathe is equipped for "outboard" turning. Work can then be mounted on it by means of a special faceplate to overhang the end of the lathe bench, as shown in two of the accompanying photographs. Only the lowest speeds must be used for such large turnings, and it is wise





Above, using the blade of a square to check the flatness of a turning. At left, steps in truing up a disk, how to mount work without screws, and three types of built-up blanks

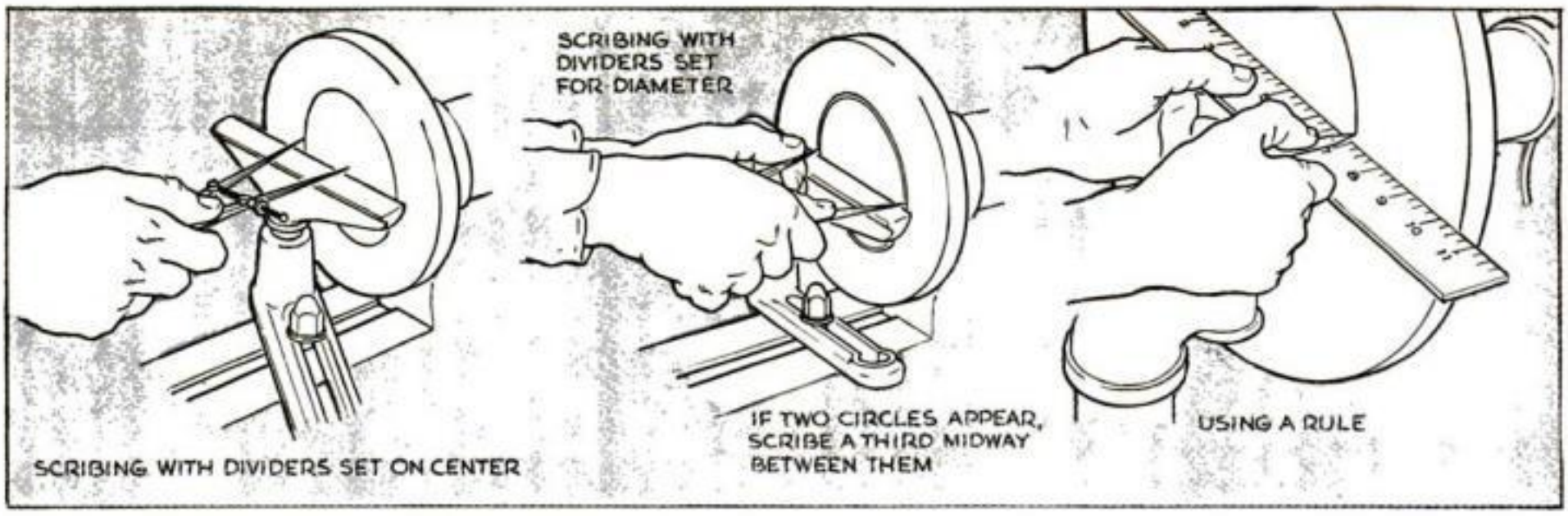
Craftwork

not to stand in line with the work, or to allow onlookers to do so, when the lathe is running.

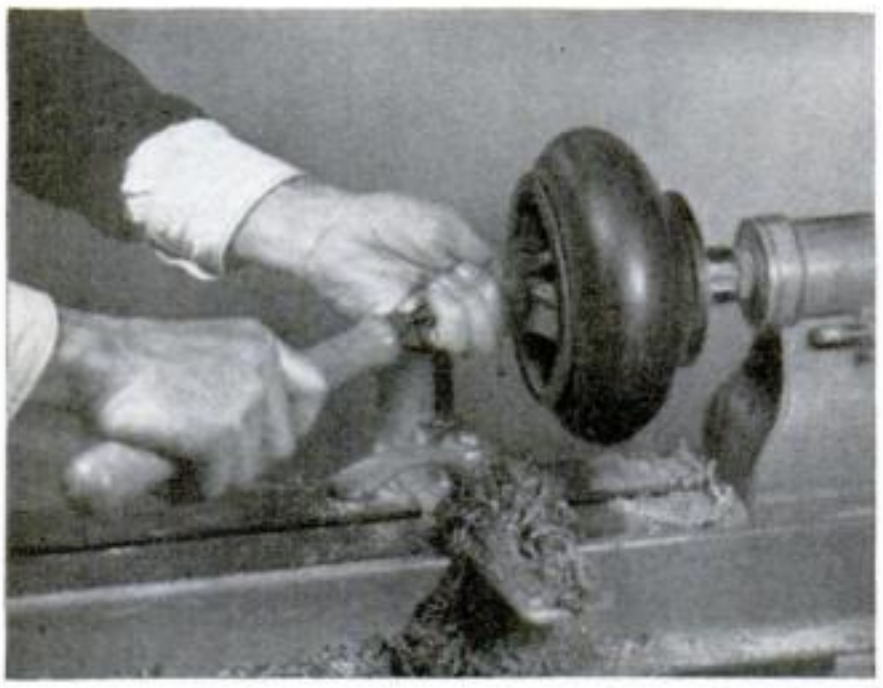
How is the face of a disk turned to shape? Mark shoulders, beads, hollows, or other features, using a scale or dividers as in the drawings. Take sizing cuts, rough down to these with a gouge, and finish by means of scraping cuts with round, square, or diamond-pointed chisels.

What tools are used for boring? Centered holes can be made with a brace and bit, with a bit held in a tailstock chuck, or by turning. Bits used under power should have the lead threads on the point filed off to prevent seizing and breakage. Boring with a bit is quick and accurate, but odd-sized holes must, of course, be turned out. Scribe a guide line, then run in a skew or a nar-

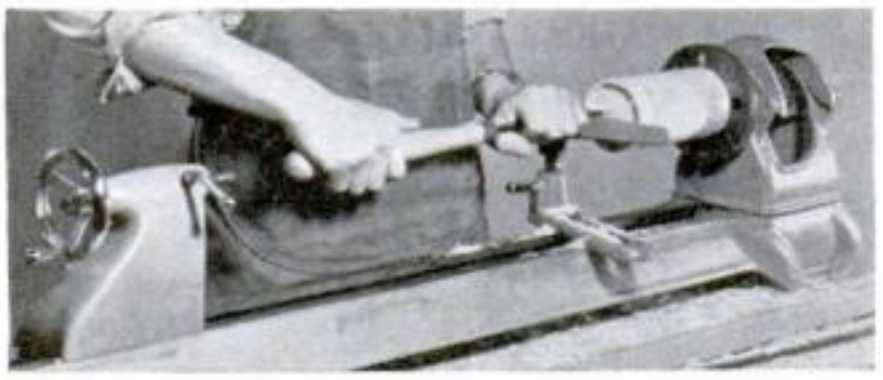
For outboard turning, the left end of the spindle must have a left-hand thread to fit a special faceplate. The work overhangs the end of the bench. Here, Robert Jaacks is turning the inside of the tray shown in the upper photo. A floor standard supports the tool rest



After the work has been turned and faced to a true disk, it may be marked off, while revolving at low to medium speed, by means of a compass, a pair of dividers, or an ordinary scale and pencil, as above



On deep inside turnings, such as the walnut bowl shown above, the rest is gradually shifted into the work in order to afford better tool support



The first step in making a box with a fitted lid is turning the inside of the latter. Diagrams on the facing page show this and following operations

Mandrel mounting affords a rapid means of turning small rings and similar parts with a hole through them. The mandrel itself must have a slight taper

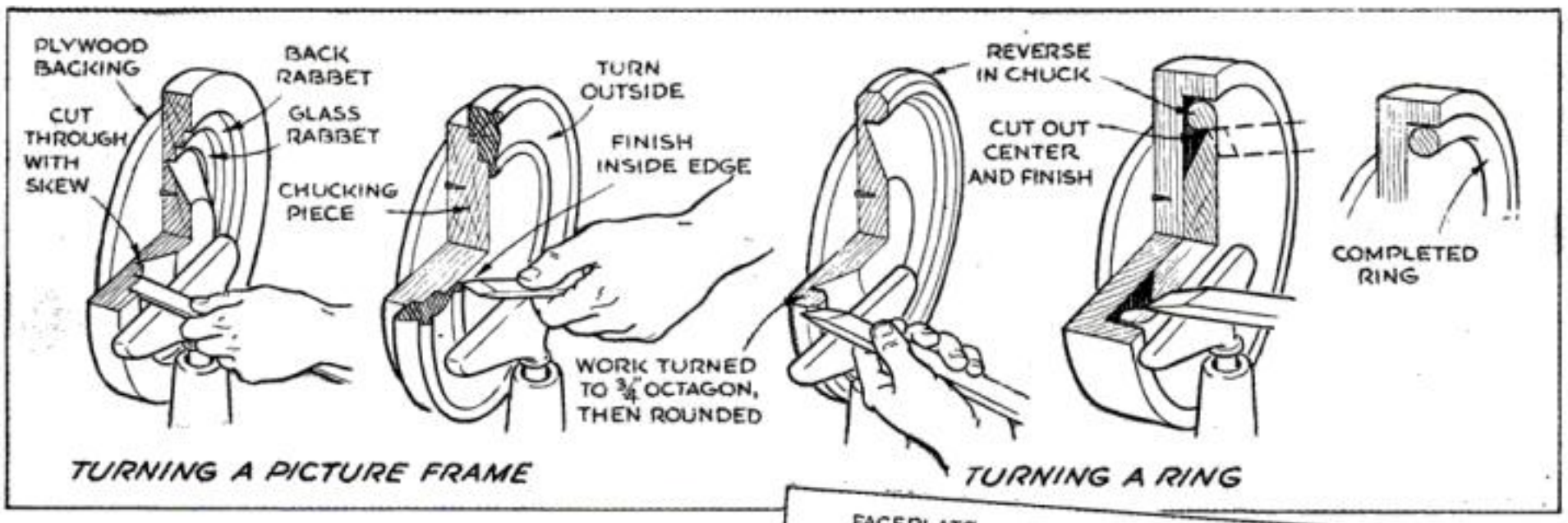
row chisel, withdrawing it often to avoid overheating the edge. Hold the tool square, else the bottom of the hole will be too large or too small. Finish with a square or round-nose chisel, according to the desired profile.

How are pieces such as picture frames turned on both faces? Mount the work on a backing of ¼" plywood, so that there will be no danger of running the tool into the faceplate. Turn a recess or rabbet for a backboard to hold the picture in, and another for the glass, as shown in the drawings. Then turn out the center, leaving 1/16" of stock for smoothing, and cut off what is now a rim turned on one side. On the faceplate, turn a wooden disk from scrap stock with two steps to fit the rabbets on the frame. Force the frame on this, seating it accurately, and turn and finish the front and edge.

How is a ring with a circular cross section turned? Mount a disk on the faceplate, true it up, and turn a square rim, nearly but not quite cutting through to the back. Chamfer the three corners until a three-quarter octagon section is made; then chamfer these edges. This soon produces a nearly round profile that is finished with a swinging cut around the rim. Sand the finished part, remove the work from the faceplate, and turn a chuck with a recess into which it will fit. Mount the partly shaped ring with the unshaped side out, cut out the center waste, and turn round as before.

What method is used in turning a bowl? Glue up stock to form a blank of the necessary size. Turn the outside, rough out the inside with a gouge, and smooth it with a round-nosed scraper. As the tool edge may extend some distance beyond the rest, the chisel must be firmly held. Use cardboard templates to check the contours.

How is a box with a fitted lid turned? Screw the blank to the faceplate; then turn the inside and the flange of the lid. Cut off the lid, hollow out the box, turning a flange



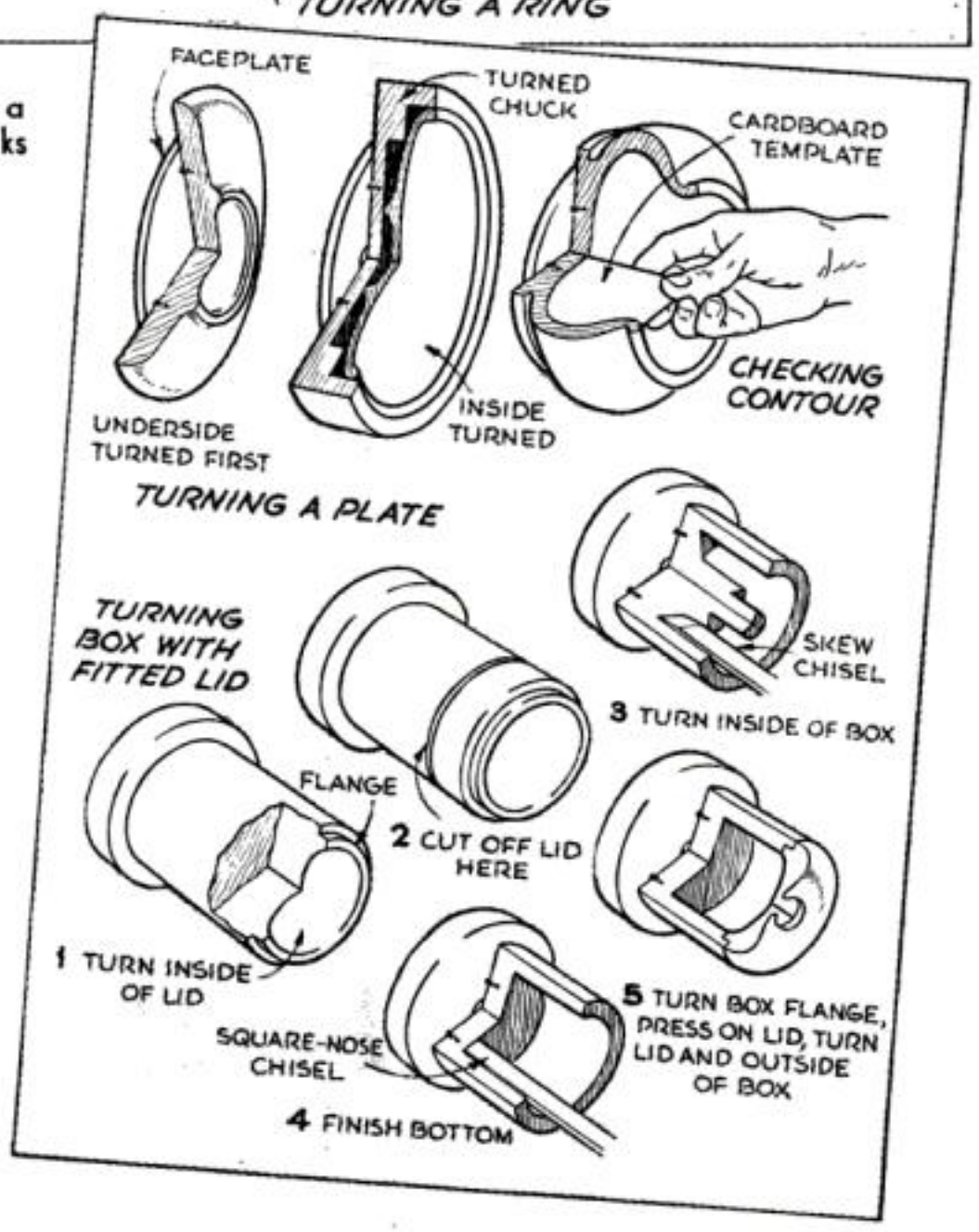
Above, steps in turning a picture frame and a large ring, illustrating use of turned chucks

to fit the lid, and force the lid on. Turn the top of the lid and any ornamental grooves or the like on the outside of the box. Finally, remove the lid and relieve the flange on the box for a slightly easier fit. If you wish, you can apply an excellent shellac finish while the work is still chucked in the lathe, as explained below.

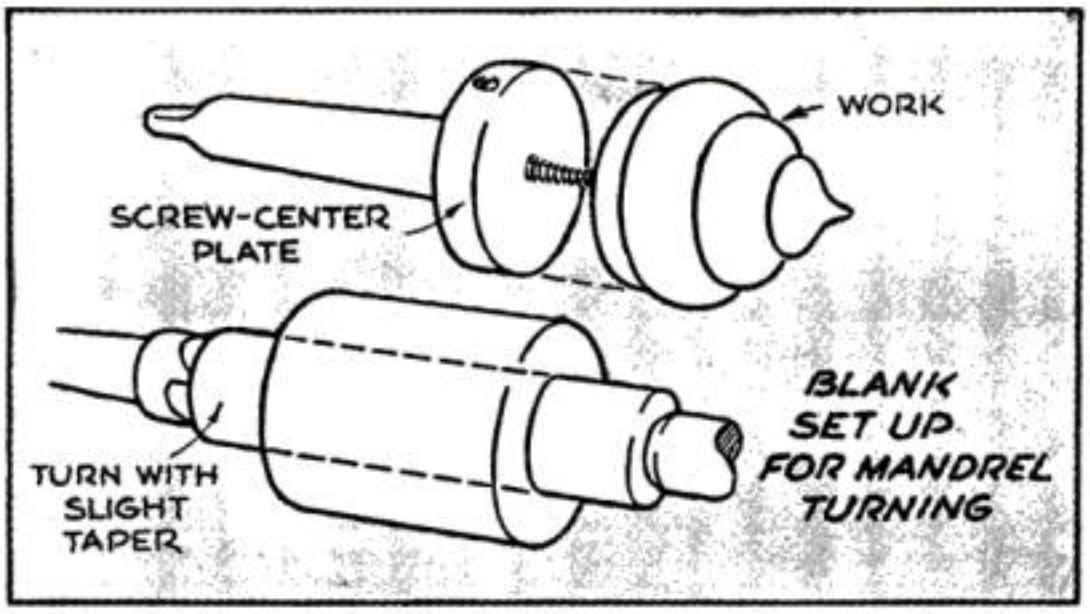
What is mandrel turning? This is an easy way to mount small articles with holes through them, such as napkin rings. Bore a hole through the blank, force it over a short, slightly tapered spindle, and turn the outside. Remove the work from the mandrel and press it into a turned chuck for further work on the inside.

Mandrels are easily made in any size required. They will usually grip work better if not sanded smooth.

How is French polishing done? This shellac finish is applied while the lathe rotates at low speed. Have at hand three bottles, one containing white shellac, one boiled linseed oil or machine oil, and one denatured alcohol. Roll up a small ball of lintless cloth with the edges folded in, and saturate it with shellac. Add a little oil, and apply the pad to the work. If it tends to catch or pull, add a little more oil. However, the less oil used, the better. When a good body of shellac has been built up, let it dry thoroughly, then repeat. Finish by rubbing lightly with a fresh pad dampened with alcohol to remove excess oil. Never use waste for French polishing, as shreds may catch, spoiling the finish and possibly drawing the fingers into the revolving work.

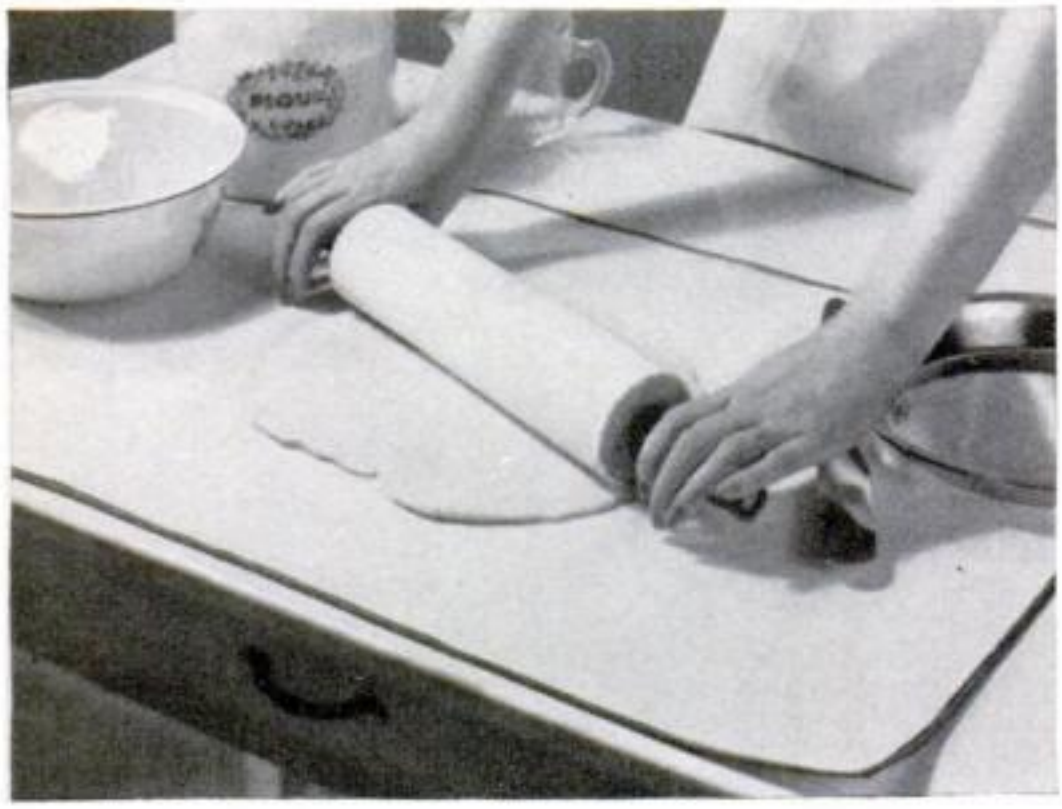


Turning the outside and inside of a plate or a shallow bowl, checking inside contours with a template, and the steps in making a box with a fitted lid, are shown above



A screw-center plate is convenient for the mounting of small work. Mandrels are easily made in any size needed

New Appliances

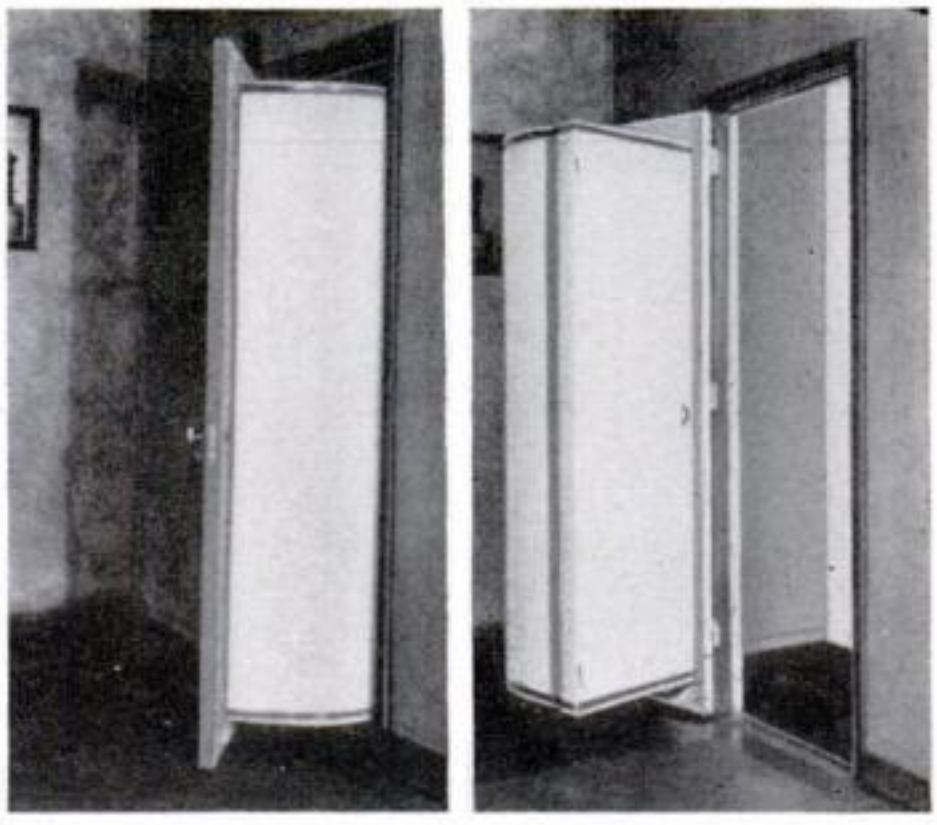


KITCHEN UTENSIL MENDING without the use of special tools is possible with this plastic, which is squeezed out of a tube into the cleaned hole in the bottom of the cooking pot and smoothed with the fingers. The new mender will stick equally well to utensils made of aluminum, stainless steel, enamelware, graniteware, or cast iron. Dried hard overnight, it will withstand great heat

NONSTICKING PASTRY CLOTH turns a table top into a biscuit board. Made of unbleached cotton canvas with bound edges, it is treated with a water-repelling substance that keeps flour rubbed in by the cook from sticking to moist dough and makes washing rarely necessary. The cloth is of special use when dough is rolled thin for pastry, biscuits, and cookies. It is available in a set with a knitted rolling-pin sleeve

TUCKED AWAY ON THE INSIDE OF A CLOSET DOOR,

Wasted space behind a closet door in the bedroom, living room, bath, or kitchen can be converted to storage, dressing, or work space with one of the door units shown below and on the facing page. In addition to the wardrobe and bureau units, there are available a kitchen cabinet, bar, and linen drawers. Floor space occupied is only 2½ sq. ft.

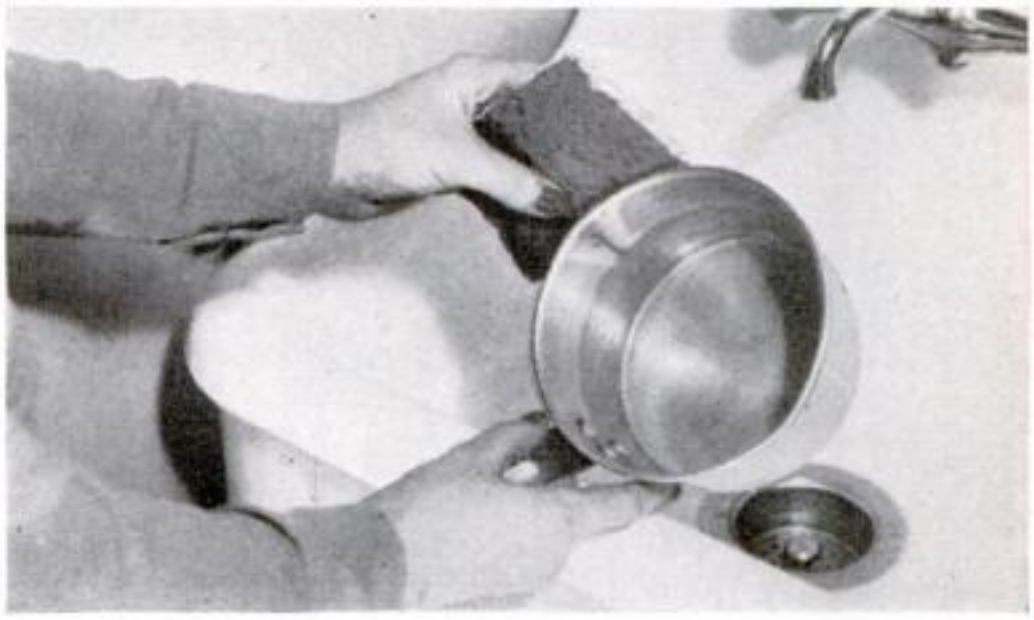


COFFEE OF ANY DESIRED STRENGTH is automatically made with the electric percolator above. The dial at the base is adjusted at mild, medium, or strong, and when percolation reaches that point it stops. An automatic unit then cuts in to keep the coffee hot until used. A glowing eye over the dial gives visible notice when the coffee is done

for the Household

AN IRON FLOWERPOT BRACKET that is almost invisible grips the pot at the top with a deep hook and at the bottom with a forked base which can also be adjusted to hold an attached or unattached drip saucer. The bracket is fastened to the window frame or other woodwork with two screws. It comes in two sizes, each adjustable to three heights of pots, the smaller size holding pots from 3" to 4½" tall and the larger holding those from 4½" to 6". The bracket is painted black or white to give an inconspicuous finish

THREEFOLD IN PURPOSE, the sponge at right acts as a dish-washing cloth, pot cleaner, and polisher. One of its sides is left natural for use in dish washing, and baked into the surface of the other is a pliant plastic containing a coating of two different grades of abrasive. On half of the plastic, a coarse abrasive is serviceable for pot cleaning; and on the other half, a finer grade does the work of a polisher. When dry the sponge is hard, but when it is soaked in water for a while it becomes as soft as cotton



THIS WARDROBE OR BUREAU UNIT PROVIDES ADDED SPACE OR A PRIVATE DRESSING ROOM

Sensitive Dial Indicator

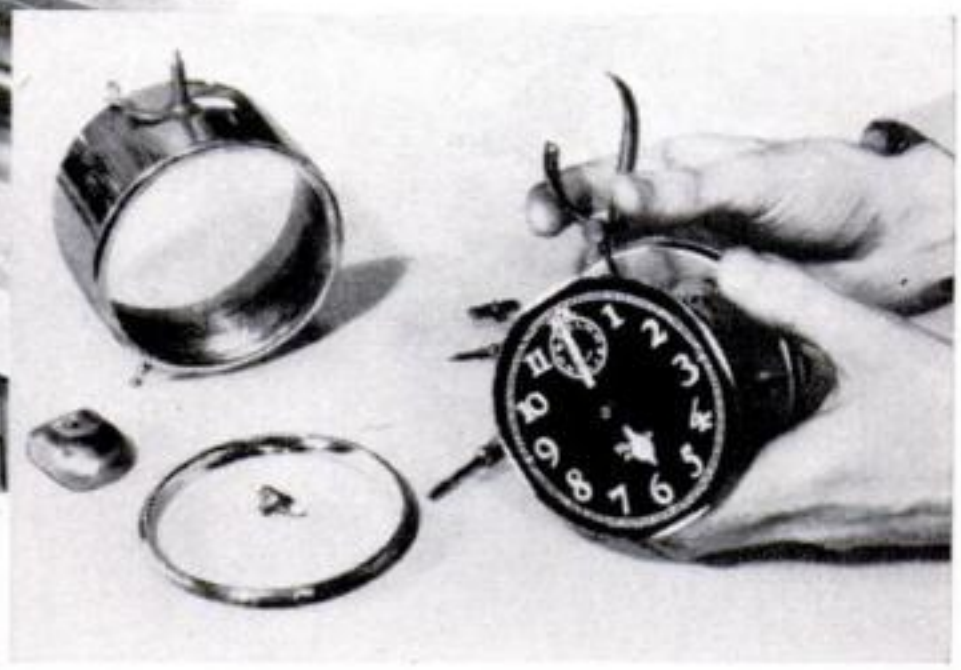
BUILT FROM ALARM-CLOCK PARTS

By

HENRY and RICHARD HANSCOM

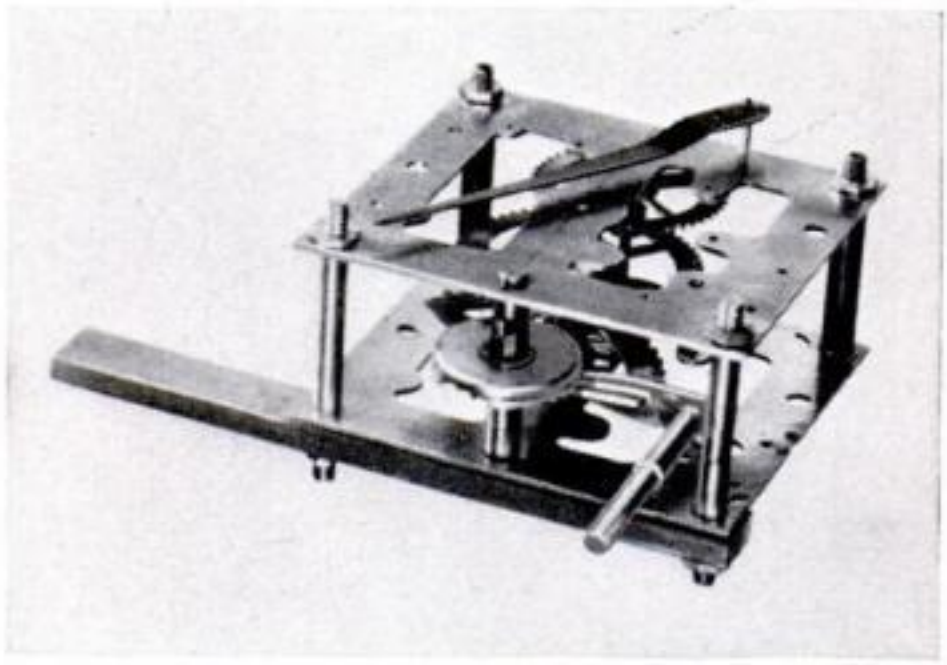
WITH defense needs clamoring for the nation's output of precision instruments, what is the student machinist to do if he needs a dial indicator, so indispensable for centering work in the lathe? One answer is to make his own. The homemade indicator shown at the left checking work held in a steady rest multiplies any eccentricity by 100, so that a movement of .001″ on the pin shifts the pointer about 3/32″.

Most of the parts can be taken from a cheap alarm clock (Fig. 1). Discard everything except the frame of the mechanism, the studs and nuts that hold it together, the three biggest gears with their shafts and pinions, and the hairspring —the parts shown in Fig. 2.



1 An old alarm clock will furnish almost all the parts for that dial indicator you've been wanting! The first step is to take the timepiece apart

4 The pick-up rod bears against an extension arm soldered to the largest gear. Though shown, the pointer is not permanently attached until later



To make the pointer pivot on the center line, it may be necessary to drill new bearing holes for the smallest gear as indicated in Fig. 9. Be sure they are smooth and accurately aligned. Drive a small brass block on the shaft and clinch the inner end of the hairspring in a 1/32" hole drilled into it. The outer end of the hairspring is secured by means of a wedge in a slotted block soldered to the frame as shown in Fig. 3 and in the drawings. To the gear itself solder a bit of thin rod or tubing bent at a right angle to project above the frame and carry the pointer.

The case studs on both sides of the largest gear are replaced with new ones long enough to secure the clamping bar to the frame. A transverse bushing for the pick-up pin, made of ⅛" inside-diameter brass tubing, is soldered to a spacer of the same material that is slipped over one of the studs.

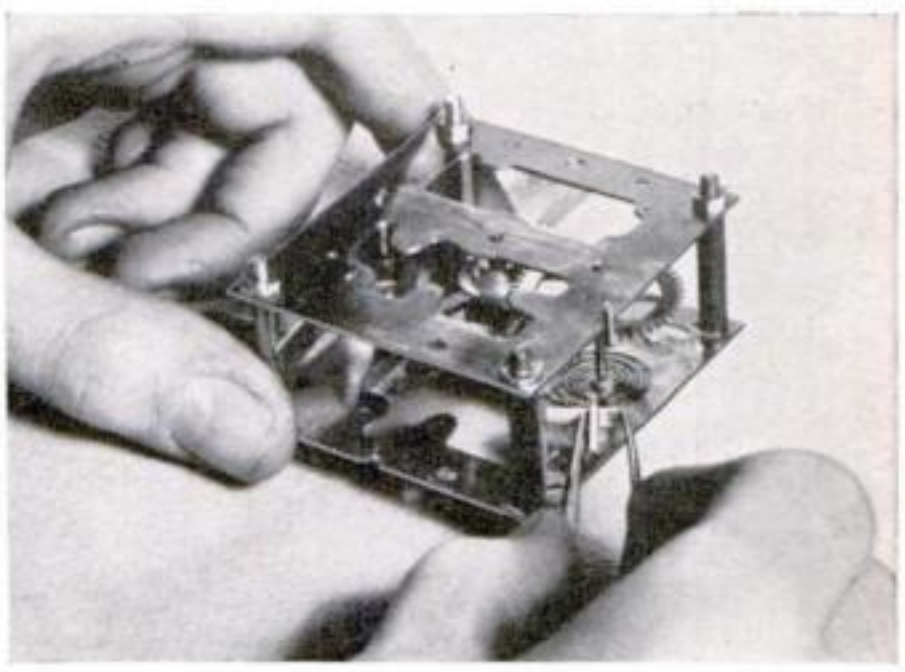
About three fifths of the largest gear is cut away. The brass pick-up lever is soldered to the remaining segment as may be seen in Fig. 4. This lever is long enough to bear against the stud.

Assemble the mechanism with the clamp bar in place. Pull the hairspring taut enough to hold the pick-up lever against the stud, and wedge the free end of the spring in the slot to hold it so. Cut the pick-up pin from ⅛" steel rod, round off both ends, and polish them smooth with fine emery cloth.

If it is considered necessary to keep the pin from falling out of the bushing, the latter may be slotted and a bit of wire driven into a hole in the pin after it is in place, but the slot must be very cleanly cut to prevent friction. The indicator will, however, work perfectly with the pin left removable, as shown.

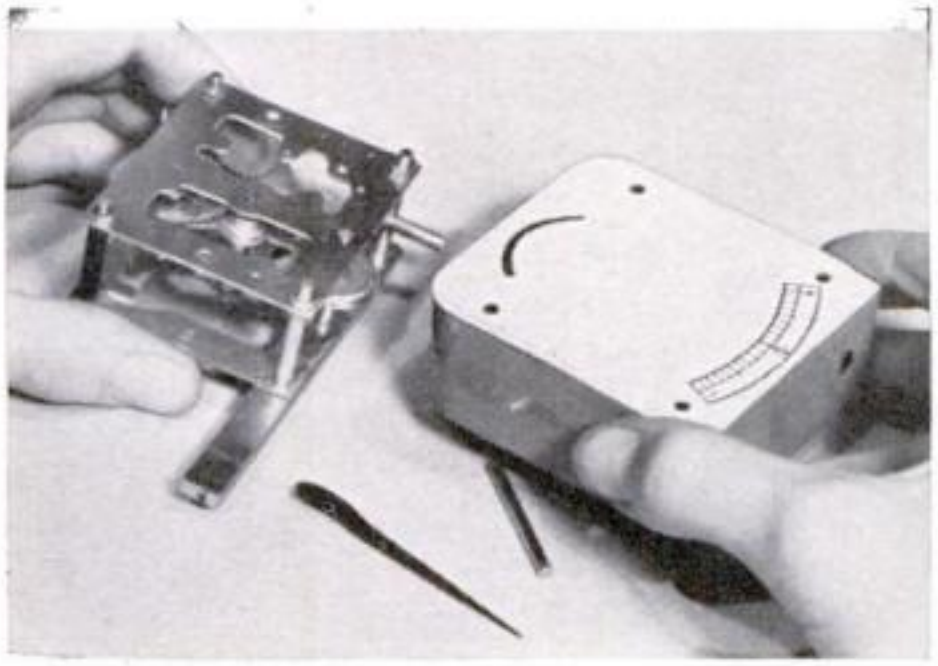
Cut the parts of the cover from thin sheet metal and solder it up from the inside. A paper pattern helps in locating the holes for the studs and the position of the curved slot. Four additional brass nuts threaded on the studs hold the cover in place. Figure 5

2 You will need the frame, the three largest gears, and the hairspring. Play between the teeth does no harm; the spring will take it up

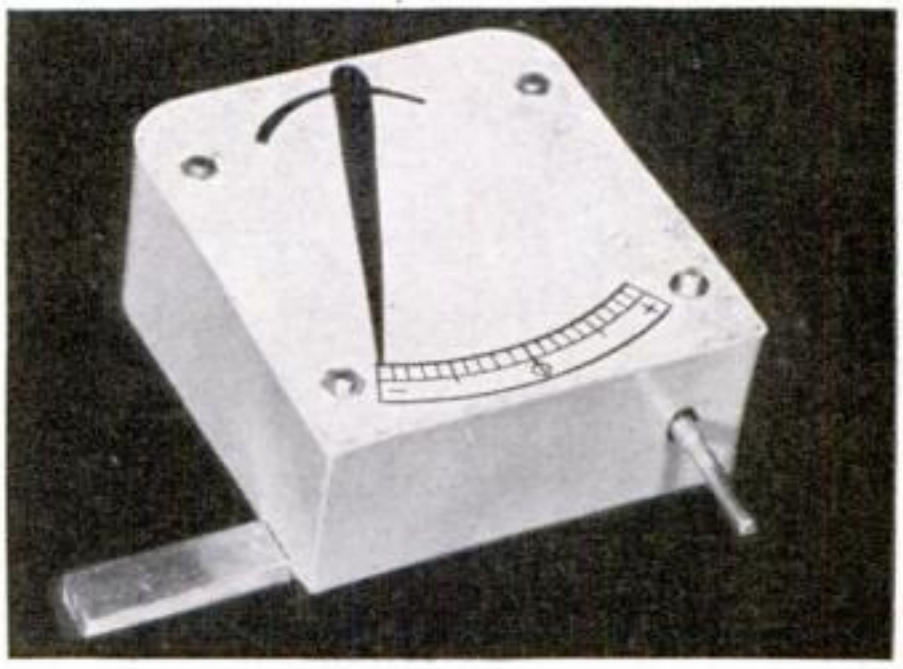


3 After the parts are assembled as described in the text, the hairspring is drawn taut and its outer end fastened by means of a small metal wedge

5 The case is made of sheet metal, with holes to fit the studs and a slot for the pointer bracket. A separate cover plate is used beneath



6 Use cardboard, white celluloid, or metal for the dial face, which also fits over the studs. The scale is drawn on in ink, engraved, or etched

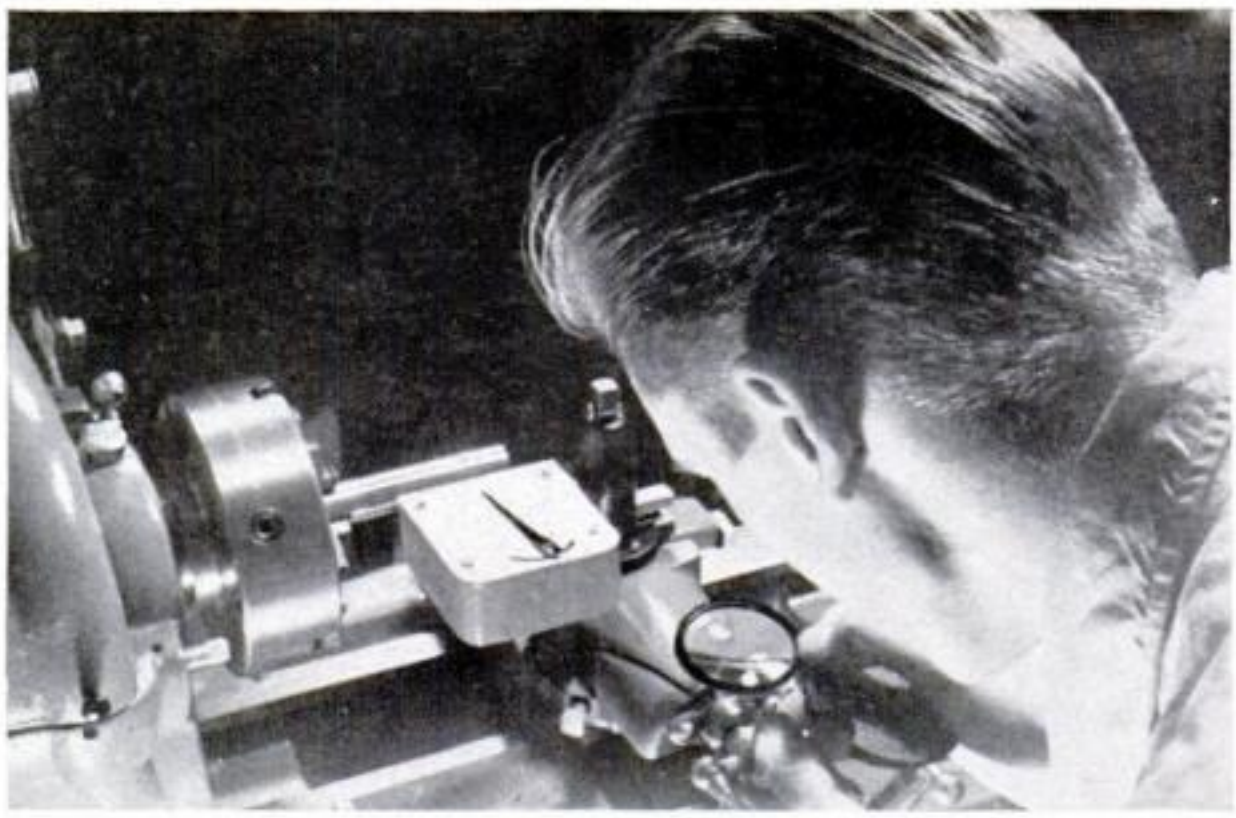


shows the latter all ready to be mounted on the mechanism.

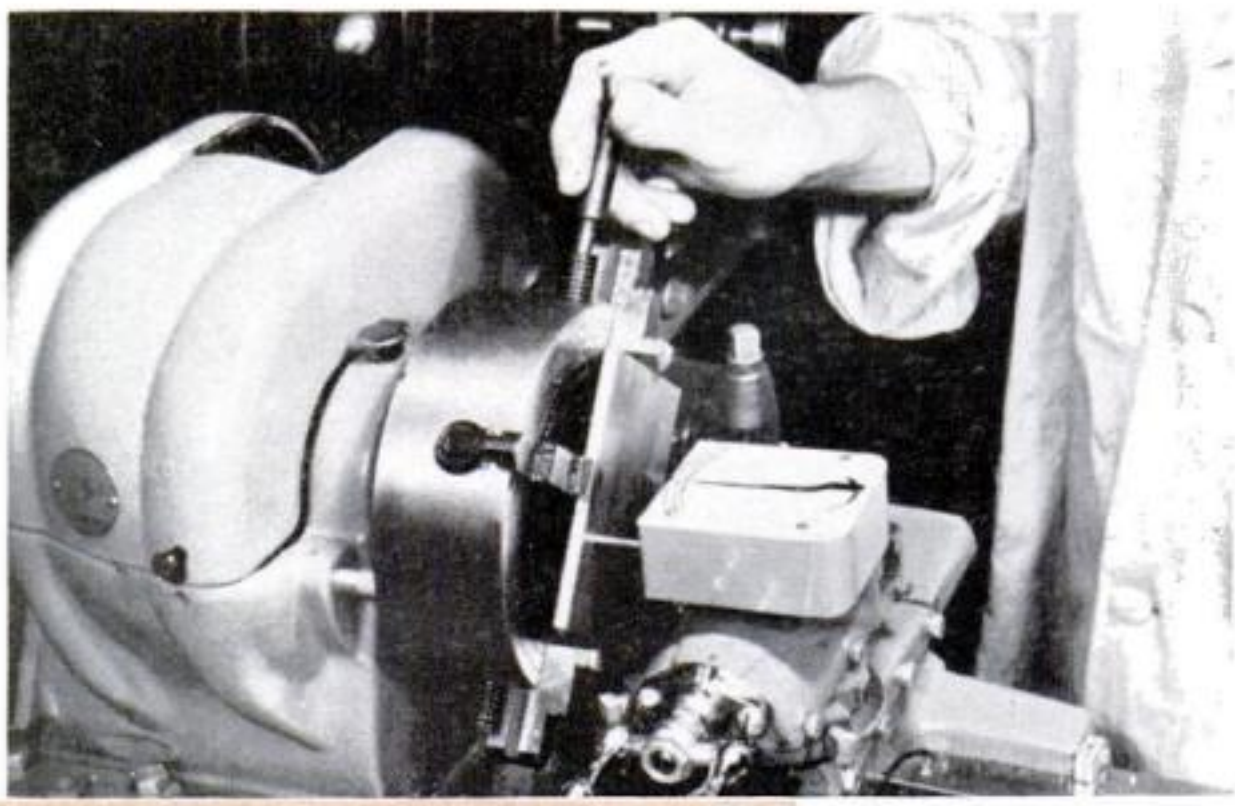
Solder the pointer to the bracket pin so that it rests at one end of the scale; then mount the indicator in the tool post of the lathe to bear against a piece of stock in the chuck with the pointer over the mid-point of the scale. Advance the indicator against the stock .001" at a time by means of the calibrated sleeve on the cross-feed (Fig. 7). Make a temporary mark under the pointer at each setting. Repeat the process on the other side of the scale by withdrawing the indicator from the stock.

This method of calibration should be repeated several times to achieve maximum accuracy. Finally, ink in the scale markings (Fig. 6) and paint the case gray or any desired color.

In using the indicator, set it against the work so that the pointer rests over the mid-point and revolve the stock slowly by hand. The pointer moves to one side or the other to indicate any eccentricity.



7 Our finished indicator is calibrated on the lathe. Repeat the process several times, using a magnifier for greater accuracy



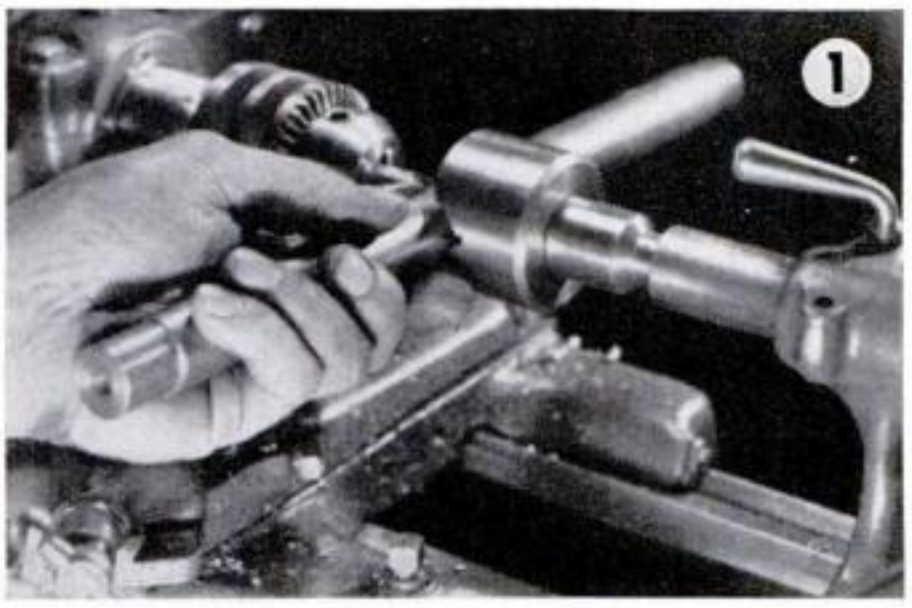
8 Above, the finished indicator being used to check a plate mounted in a four-jaw chuck. For between-center work turn it to position shown at top of page

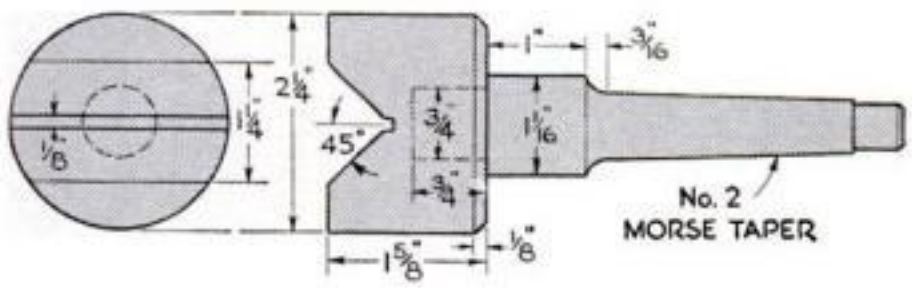
9 Although details of various clockworks vary, these diagrams show the main changes to be made. Be sure the pick-up pin works freely and is smoothly polished

Crotch Center Speeds Cross Drilling of Round Stock in the Lathe

MACHINISTS FOR DEFENSE

A CROTCH center is a worth-while lathe accessory. It will automatically center round work for cross drilling, save time, and insure accuracy. The work is held with the left hand as shown in Fig. 1 and advanced against the drill by turning the tailstock handwheel. A hole on a true diameter of the work and square with its axis results.

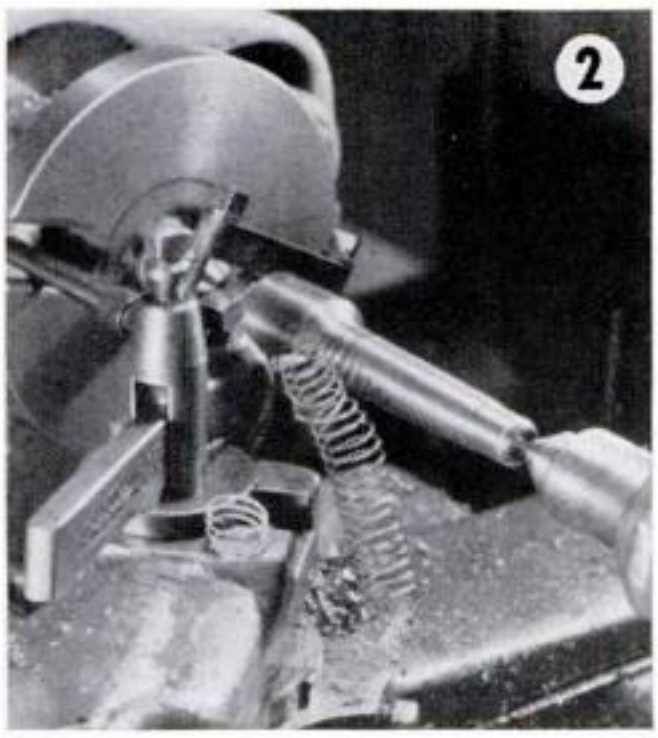


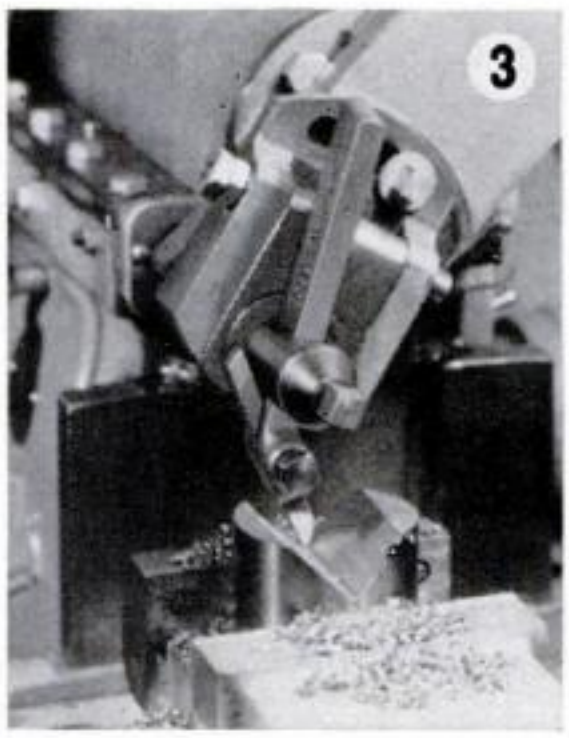


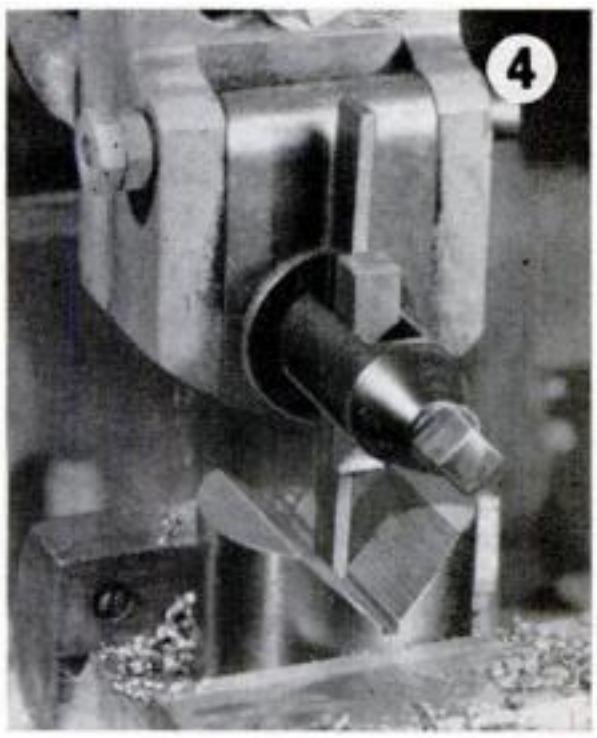
Both the crotch-center head and the shank are made from steel. Mount the stock for the latter part between centers as in Fig. 2 and turn it to a Morse taper to fit the tailstock spindle. When a perfect fit has been obtained, the straight section on the large end can be shouldered down to ¾" in diameter to receive the head.

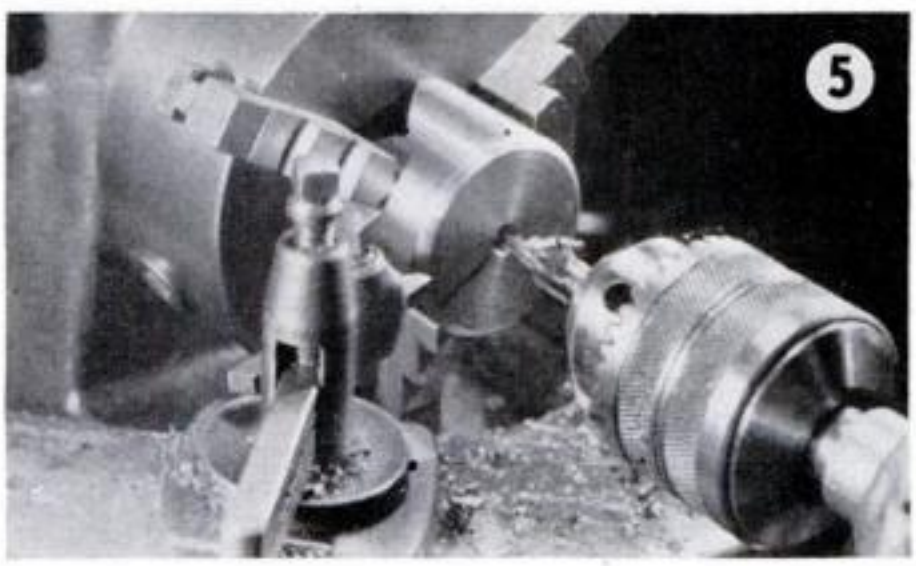
The stock for the head is next turned to size and a center line laid out on its face. It is then mounted, as shown in Fig. 3, in the swivel vise of the shaper, where the crotch must be cut accurately with the tool head set at 45 deg. The swivel vise can be turned end for end in order to permit cutting both sides of the crotch with the same tool setting. A narrow chip groove is then cut at the bottom with a parting tool as illustrated in Fig. 4.

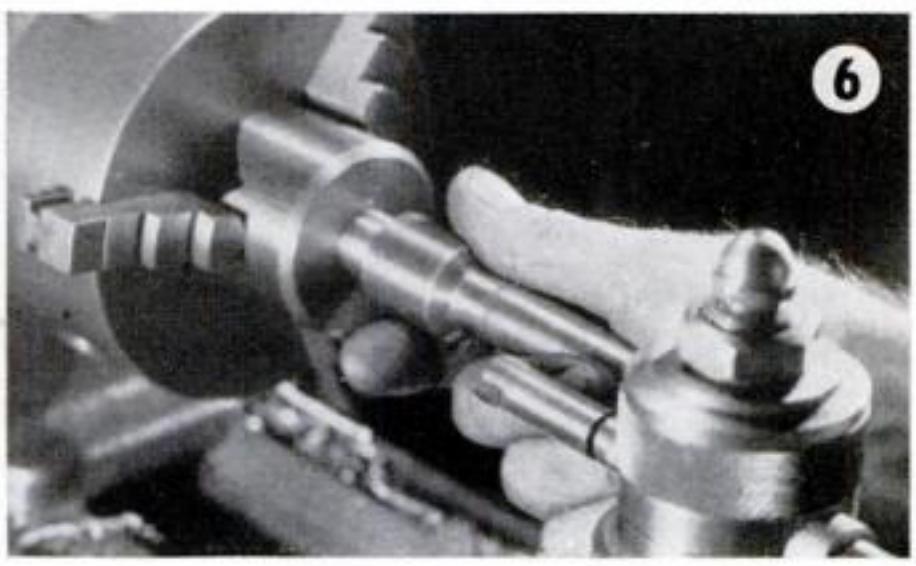
Chuck the head in the lathe as in Fig. 5 to face off and chamfer the back. Use a drill to start the hole for the shank; then bore this to size. The shank itself can be used as a plug gauge to obtain a good drive fit (Fig. 6). When the shank has been driven in place, the tool is ready for use.—C. W. W.









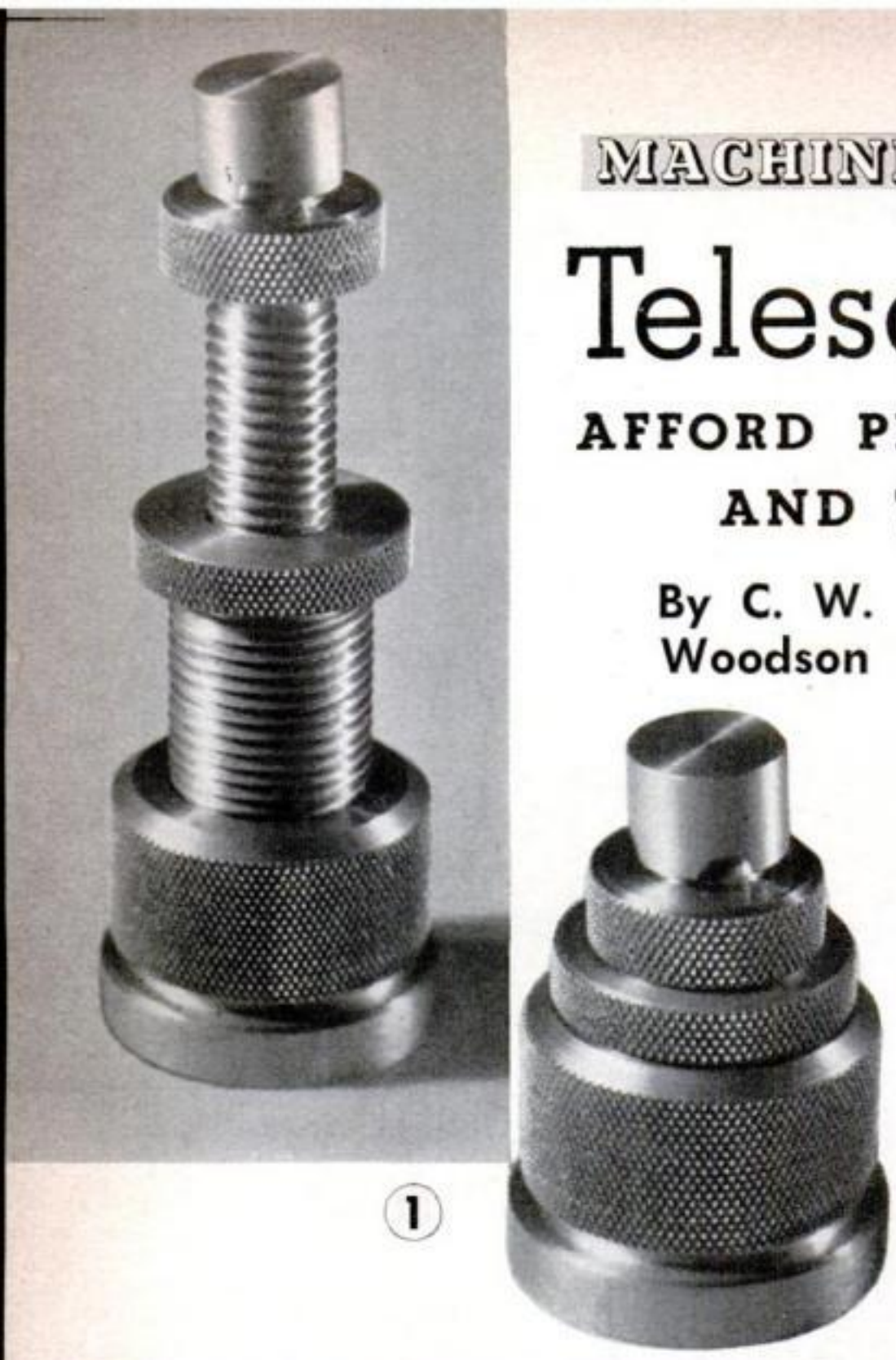


MACHINISTS FOR DEFENSE

Telescope Jacks

AFFORD PRACTICE IN TURNING AND THREAD CUTTING

By C. W. Woodson

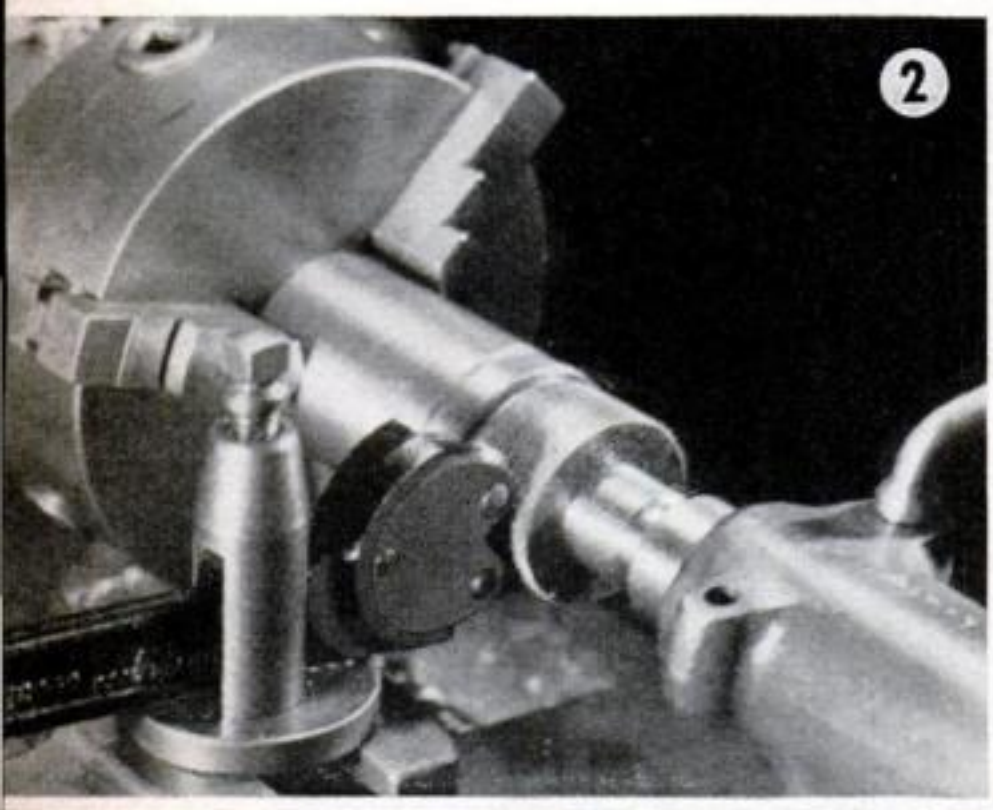


1

A SET of these telescope jacks is useful for leveling work on the shaper or milling machine. They are sturdy but easily adjusted and, if carefully used, will insure accurate, true-surfaced work.

Each jack can be raised to 5″ in height or lowered to 2½″, as shown in Fig. 1. The cap rests on a ball and will adjust itself to uneven surfaces. Great care should be used in cutting the threads so that all parts will fit together without play but freely enough to be turned with the fingers.

To make the base of the jack, a short steel bar is chucked, centerdrilled, turned to size and knurled (Fig. 2). Cut off and rechuck it as in Fig. 3; then drill, bore, and thread it to the specifications given in the drawings. The large jack screw is also turned to shape from steel, the external threads cut with the thread tool, and the



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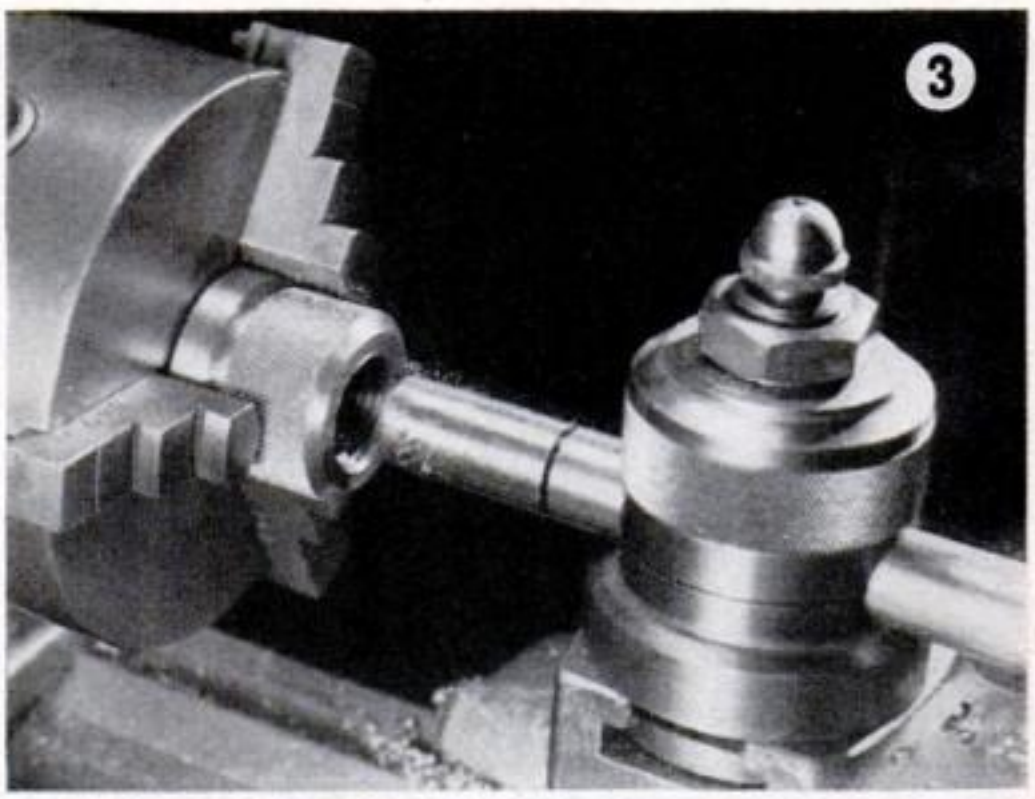

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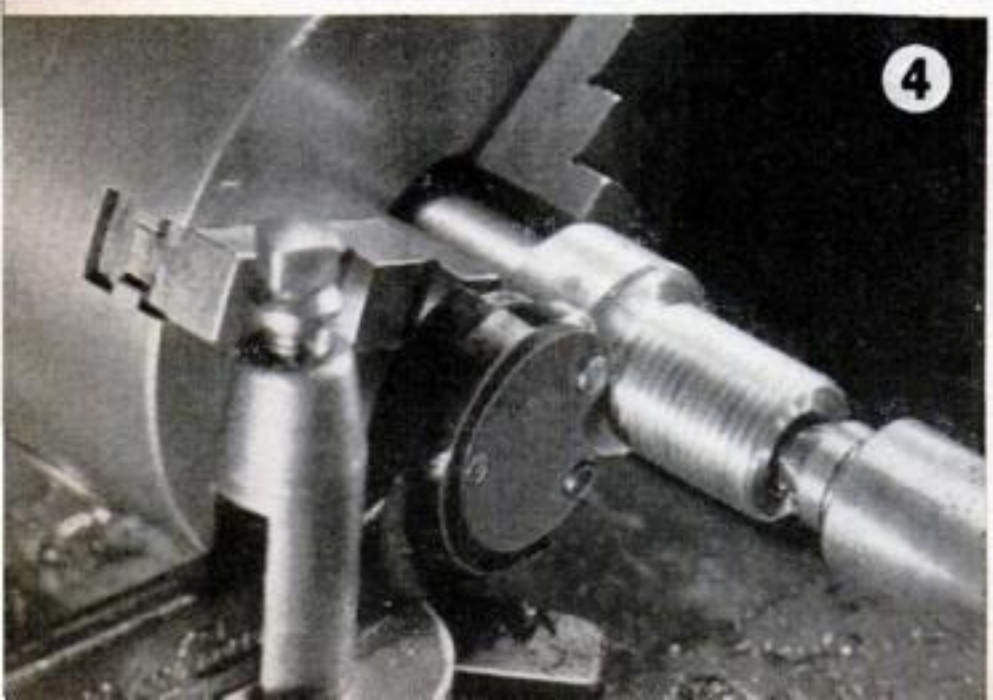

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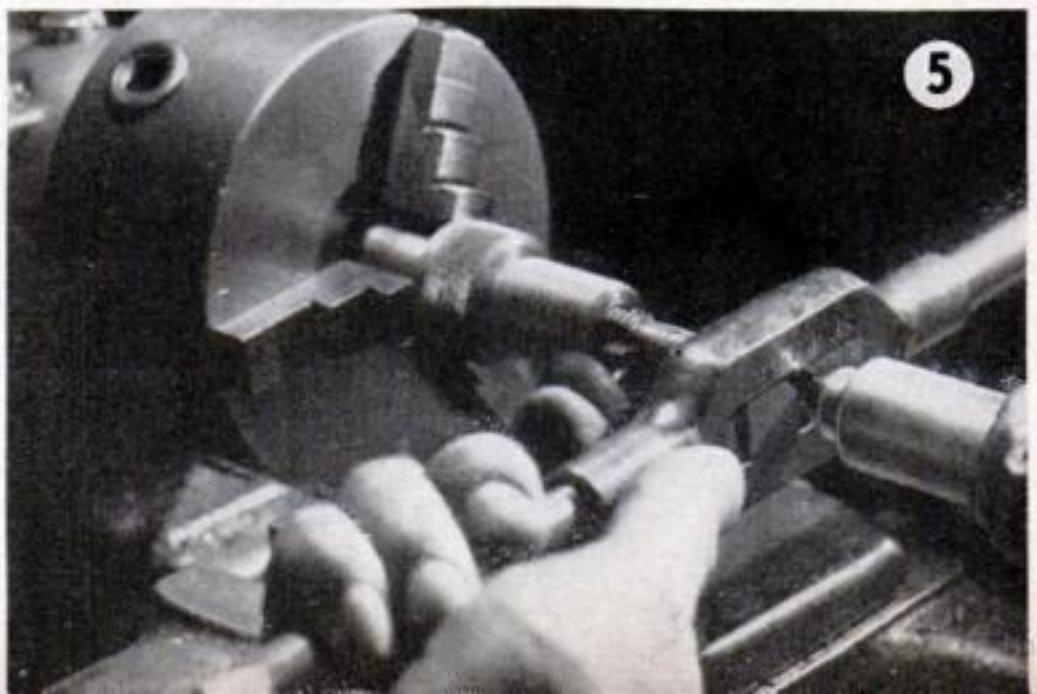

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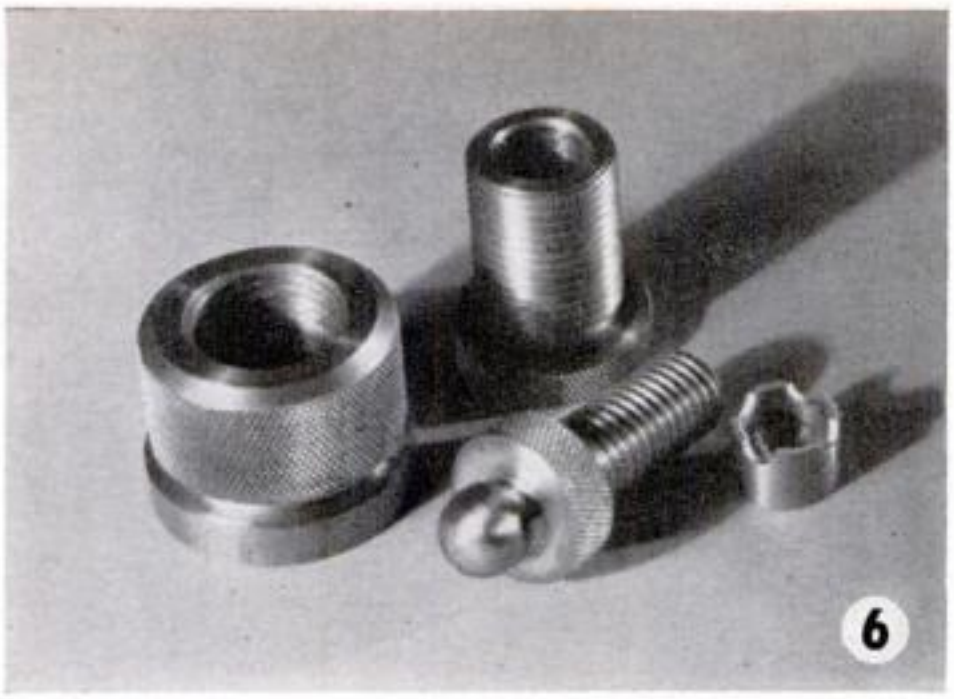
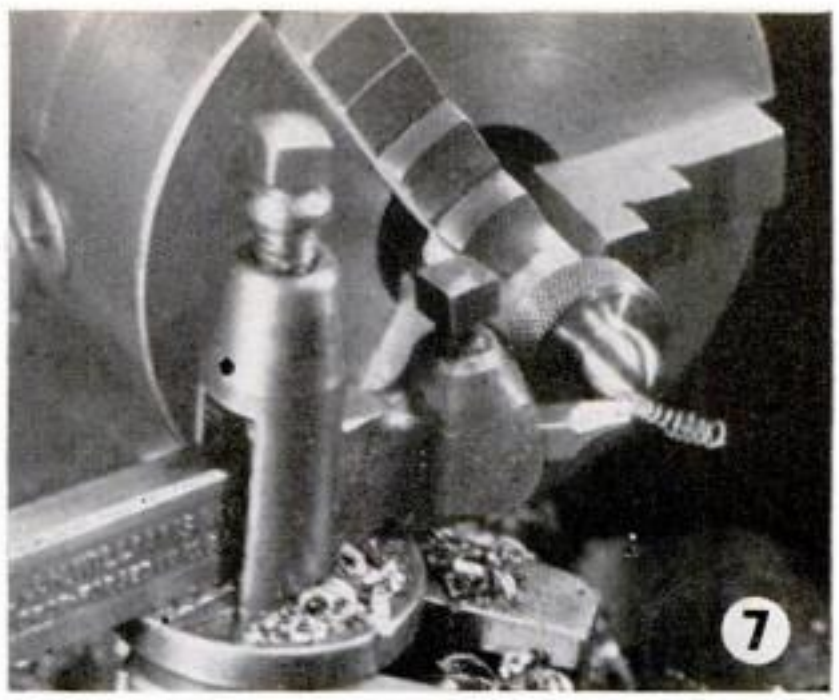
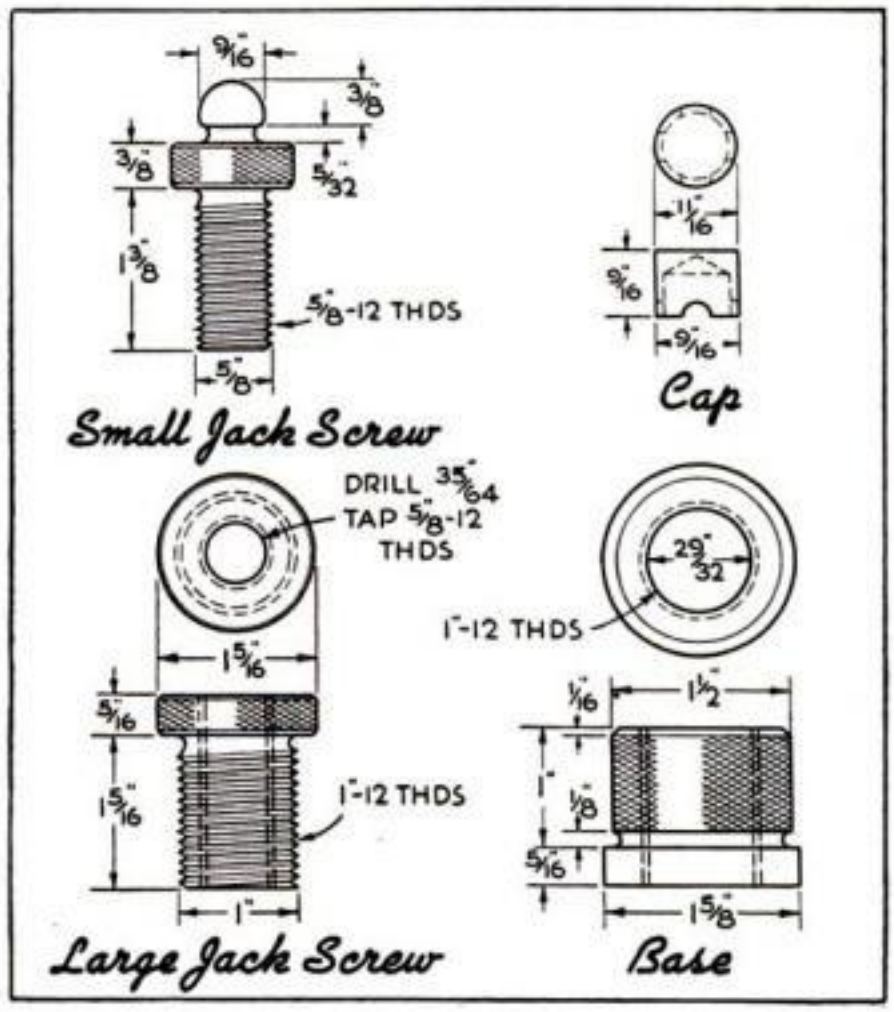




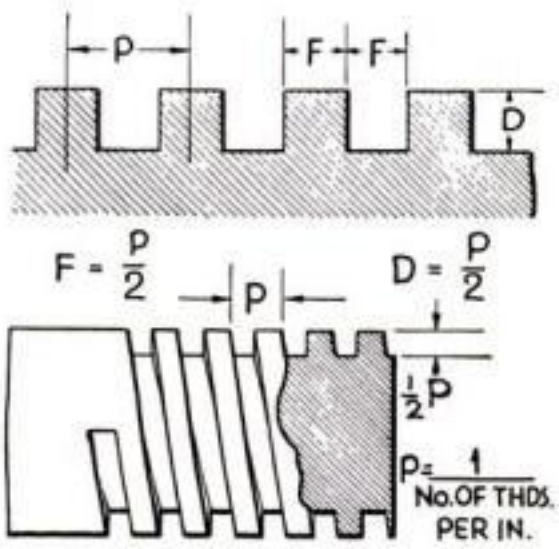
grip knurled (Fig. 4). Sink the knurls deeply into the edge of the work in starting. Move the tool slowly back and forth across the part several times, until the knurls are uniformly deep all over. The lathe should be run at a slow speed and the work, knurls, and lathe center well oiled.

At the same chucking, the hole for the small jack screw is drilled 35/64" and tapped 5/8"-12 as shown in Fig. 5. Finally the small jack screw is turned to dimensions, threaded, and reversed in the chuck as in Fig. 7. The ball can then be turned to shape, filed smooth, and polished with emery cloth.

Turn the cap on the end of a steel rod. Drill it to fit the ball, cut it off, and file the notches in its lower edge. This completes the parts for one jack, shown unassembled in Fig. 6. Slip the cap on the ball and squeeze the notched rim slightly to hold it. The jack can now be screwed together ready for use.



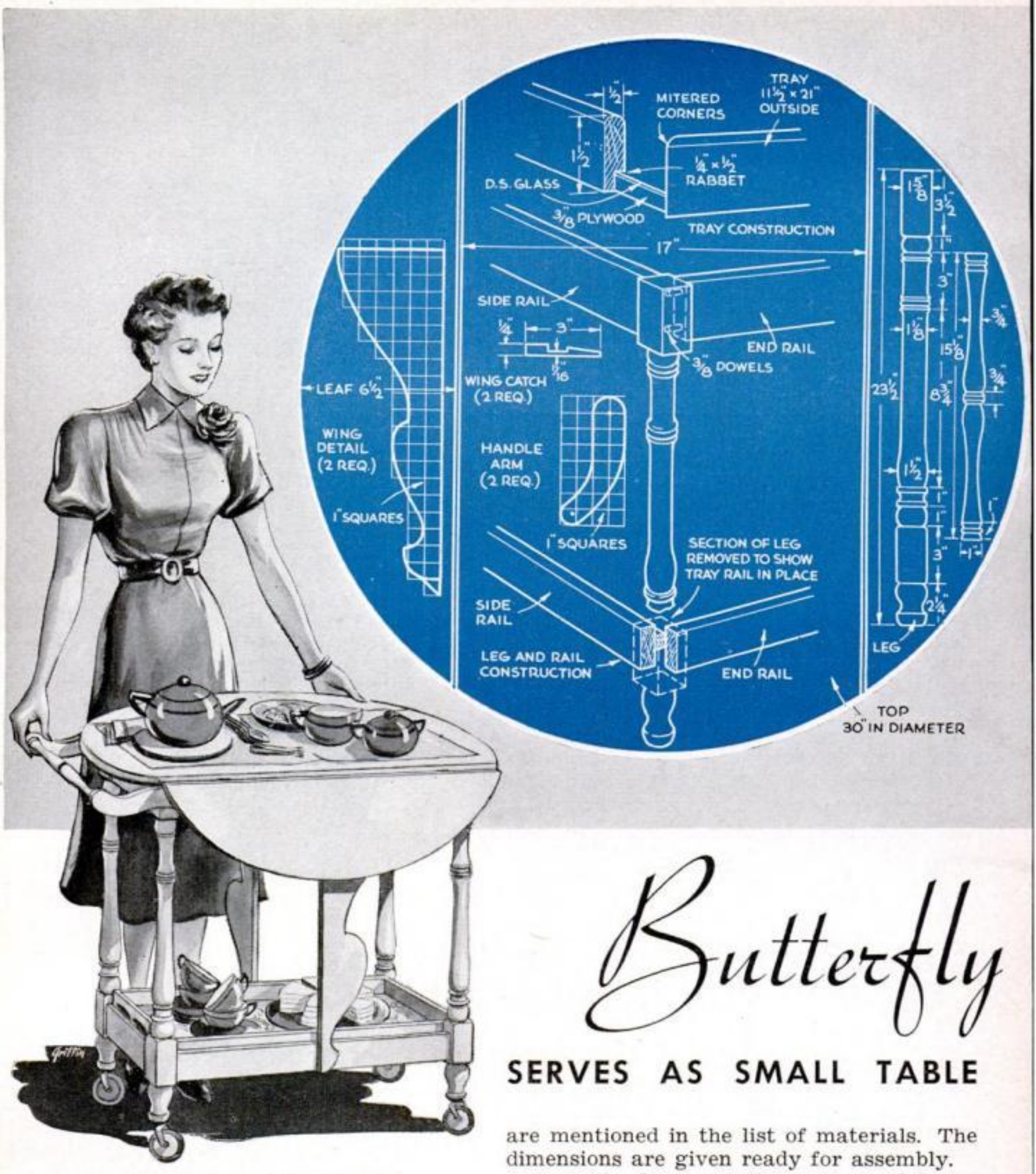
SQUARE SCREW THREADS AND FORMULA [*LATHE WORK—27*]



The square thread is often used on vise screws, clamps, and other worm-screw devices. It is hard to cut and not as strong as the Acme thread, and cannot be so closely fitted as the latter. Theoretically, the depth of the square thread, the space between threads, and the width of the thread are equal, but in practice the space is cut about .002" wider than the thread, or else the tool for cutting the internal thread to fit is ground from .001" to .003" oversize.

The tool angles for cutting a square thread with a large lead must be absolutely accurate. Clearance must be allowed on two sides, tapering from both top and front of the tool, and the helix angle must be properly determined as described in Lathe Work—26. External square threads should be cut to about .005" less than the minor diameter to allow a small clearance at the bottom, which helps compensate for any small inaccuracies in the tool or the cutting.

POPULAR SCIENCE MONTHLY SHOP DATA FILE



Butterfly

SERVES AS SMALL TABLE

By FRANK HEGEMEYER

DESIGNED in early American style, this tea wagon has drop leaves supported by butterfly wings so that it will serve as a table after the removable tray has been lifted off. Swivel-type ball bearing casters enable it to be wheeled about easily. The overall measurements are 27½" high, 30" long, and 18½" wide with the leaves down.

Hardwood is preferable for the legs and handle, but a good grade of pine can be used for the other parts. The cutting and assembling are begun in the order the parts are mentioned in the list of materials. The dimensions are given ready for assembly.

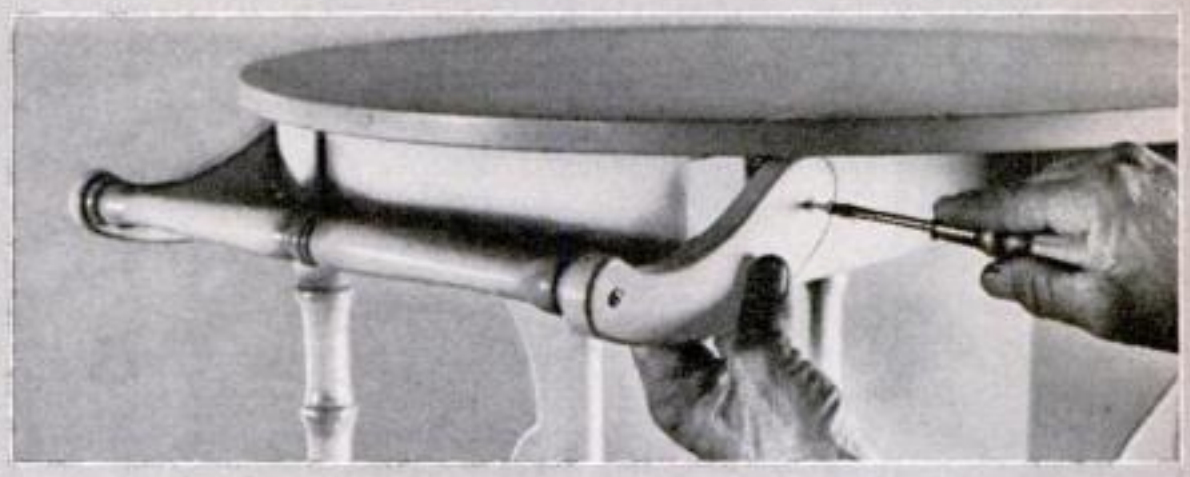
Turn the legs, cut the upper and lower side and end rails, and fasten together with dowels. The holes for the dowels should be ¾" deep. The vertical straight edge of the wings is shaped half-round and hinged to the top and bottom of the side rails with angle irons as shown.

In constructing the tray, a piece of wallpaper of early American pattern appears to good advantage if sandwiched between the glass and the plywood bottom. The latter is nailed in place with 1" brads through the sides of the frame, and the holes are later filled. To provide a place to keep the tray

Above, round off a side of the long edge of each wing. Wood screws and angle irons at the top and bottom form swivel hinges

Above at right, the table turned upside down so as to show one wooden wing catch

At right, the handle is pivoted to drop down when not needed. A washer between handle bracket and leg reduces friction



Tea Wagon

WHEN NECESSARY

when not in use, fasten ¾" square strips inside the lower side rails ½" from the top edge, as indicated.

The center part of the top is glued up in two pieces, but the leaves are each in one piece and joined to the center with butterfly hinges. Cut the top 30" in diameter after hinging the parts together. Fasten it to the top rails with six angle irons.

The wooden wing catches are nailed to the underside of the leaves 2" from the curved edge. Round off all exposed edges except the hinged part of the top.

The original piece was finished in old ivory and shaded, but a stained finish can be applied if a suitable cabinet wood is used.

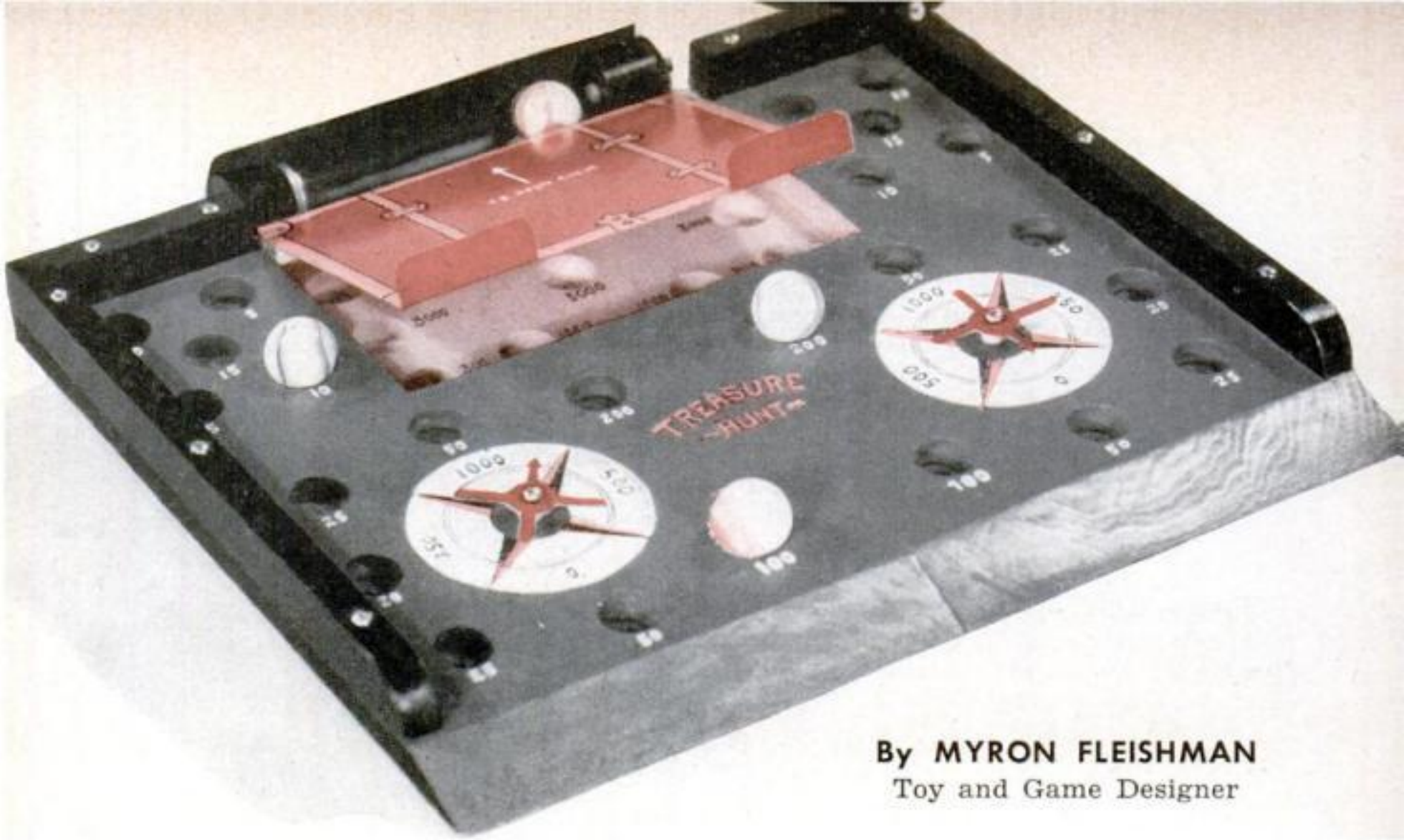
LIST OF MATERIALS

No. Pc.	Description	T.	W.	L.
4	Legs	1⅝	1⅝	23½
2	Top side rails	¾	3	20¼
2	Top end rails	¾	3	11¾
2	Bottom side rails	¾	2	20¼
2	Bottom end rails	¾	2	11¾
2	Wings	¾	6½	20½
2	Tray sides	½	1½	21
2	Tray ends	½	1½	11½
2	Tray rails	¾	¾	20¼
1	Double-strength glass		11	20½
1	Plywood tray bottom	⅜	11	20½
1	Handle	1	1	15⅛
2	Handle Arms	¾	As detailed	
1	Top	¾	30" diameter	

MISCELLANEOUS

32 Dowels, ⅜" by 1½"
10 Angle irons, 1"
4 Butterfly hinges
4 Ball-bearing casters, 3"
1 Heavy, dark felt for tray bottom, 11½" by 21"
2 Tray handles

Note: All dimensions are given in inches and are finished sizes.



By MYRON FLEISHMAN
Toy and Game Designer

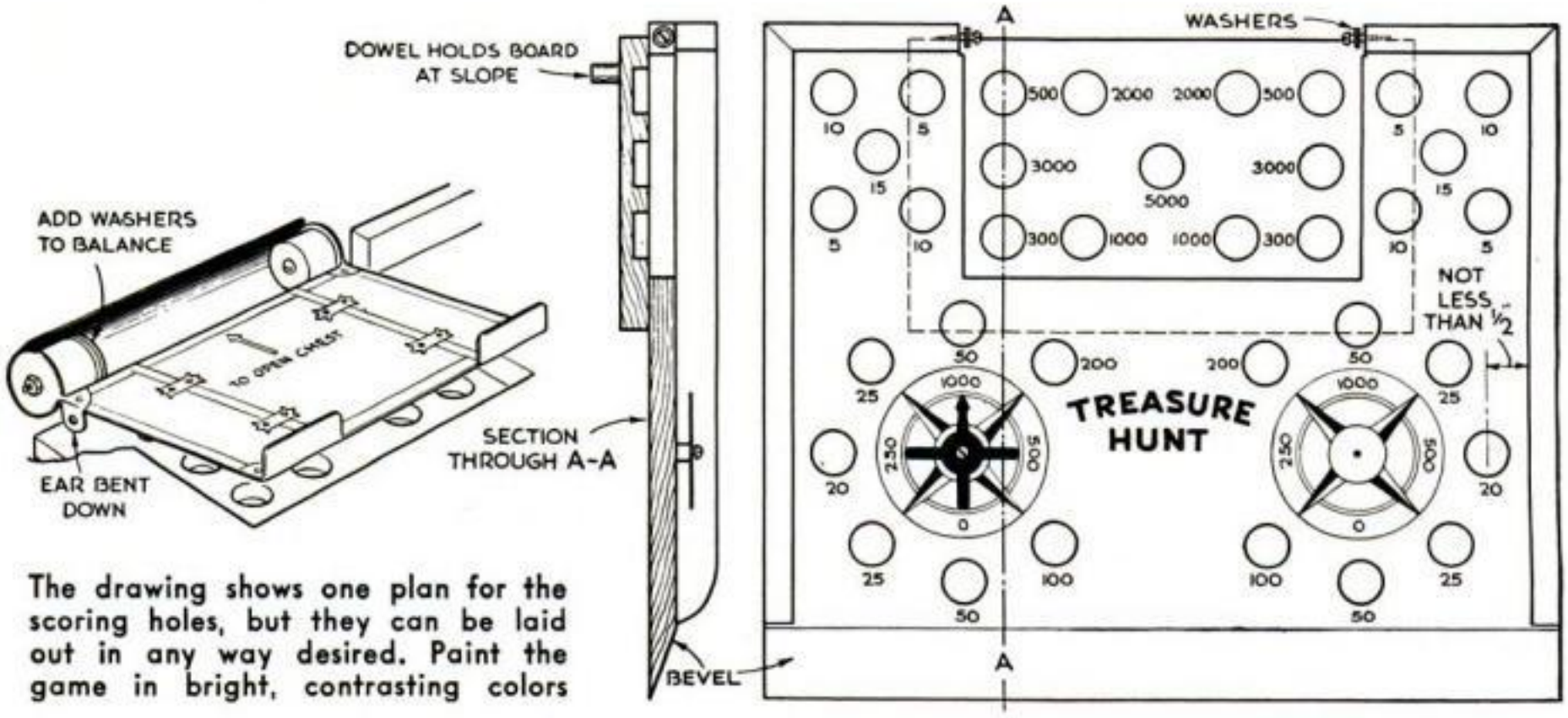
Treasure Hunt Marble Game

THERE'S a new twist to this marble-bowling game that means more fun for everybody. The player's first goal is to roll a marble across the cover of the "treasure chest." If his aim is good, the ball falls into a balance trough and lifts the cover, disclosing eleven high-score holes. To the player's final score are also added any numbers shown by the two revolving arrows.

A piece of ½" plywood or solid stock 12" by 14" forms the baseboard. Two pieces can be fastened together if a wide enough board is not available. Cut out a 4½" by 7" rectangle at one edge, and bevel the other edge sharply for the marbles to roll up. Under the cut-out section, screw a piece ½" by 5¼" by 9". Bore the scoring holes with a 13/16" Forstner bit, if available. Fit a rim of ½" by ¾" stock to the board as shown.

The chest cover and arrows are cut from medium-weight sheet metal. Form the trough around a piece of pipe or broomstick and solder in two washers for ends. Hinge the cover on two screws; then attach extra washers with bolts and nuts until one ball in the trough will be sufficient to lift it. Mount the arrows on wood screws with bits of dowel under them.

Marbles 1" in diameter are used. Each player may roll five at a distance of 5' to 7' from the board. Set both arrows at zero and close the treasure chest before each play.



The drawing shows one plan for the scoring holes, but they can be laid out in any way desired. Paint the game in bright, contrasting colors

Glass-Top Coffee Table

NAILED TOGETHER FROM STOCK LUMBER

By G. R. Sonbergh

THIS smartly styled coffee table also serves as a bookcase. Made entirely from stock lumber, it is very easy to build. The ¼" plate-glass top won't show stains or cigarette burns, is quickly cleaned with a damp cloth, and is as strong as the average shop counter.

Dressed white pine, nominally 1" by 6" and 1" by 8", was the chief material used for the original. Since actual surfaced sizes vary slightly, some changes in the dimensions given may be necessary to use the stock in whatever width it comes, but the difference will scarcely be enough to vary the proportions appreciably.

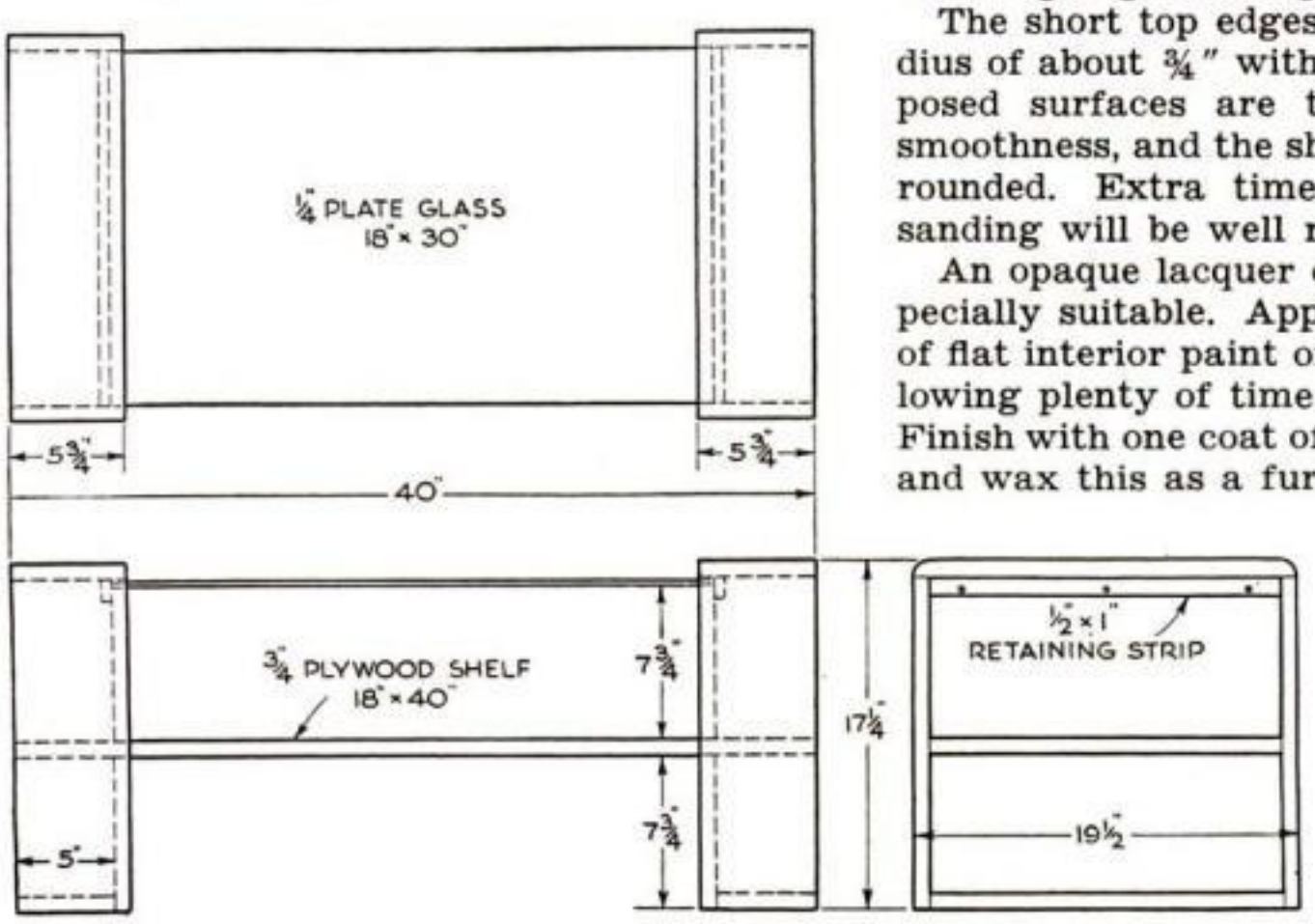
Cut the two sides, top, and bottom of each end unit from 1" by 6" stock, which in the original actually measured ¾" by 5¾". Each bottom is ripped to 5" in width. Cut the inside walls from the wider stock. The upper ones do not quite reach the top, but leave a ¼" wide opening into which the glass fits. If open-type construction is desired, the walls may be omitted, but brackets or other reinforcing pieces should be used inside the corners.

The shelf is one piece of ¾" plywood the full length of the table, thus providing maximum rigidity and forming the middle bookshelves. Assemble the two ends and fit the shelf between them. If the piece is built without inside walls, glue all joints; otherwise, nailed construction is satisfactory. All nails should be set and puttied over after the first priming coat.

The glass top rests on the upper walls and is held in by ½" by 1" flat strips. One of these may be nailed fast; the other should be attached with screws to facilitate removal or replacement of the top. A piece of ¼" plate glass 18" by 30", polished on the two long edges, is required.

The short top edges are rounded to a radius of about ¾" with a wood rasp. All exposed surfaces are then sanded to satin smoothness, and the sharp edges are slightly rounded. Extra time and effort put into sanding will be well repaid.

An opaque lacquer or enamel finish is especially suitable. Apply two or three coats of flat interior paint of the color desired, allowing plenty of time for each coat to dry. Finish with one coat of quick-drying enamel, and wax this as a further protection.



The glass top rests on the inside walls. Two strips hold it in place

Average Time 6 hours

"Clocked Project"

Part of Discarded Crankshaft Serves as a Bench Anvil

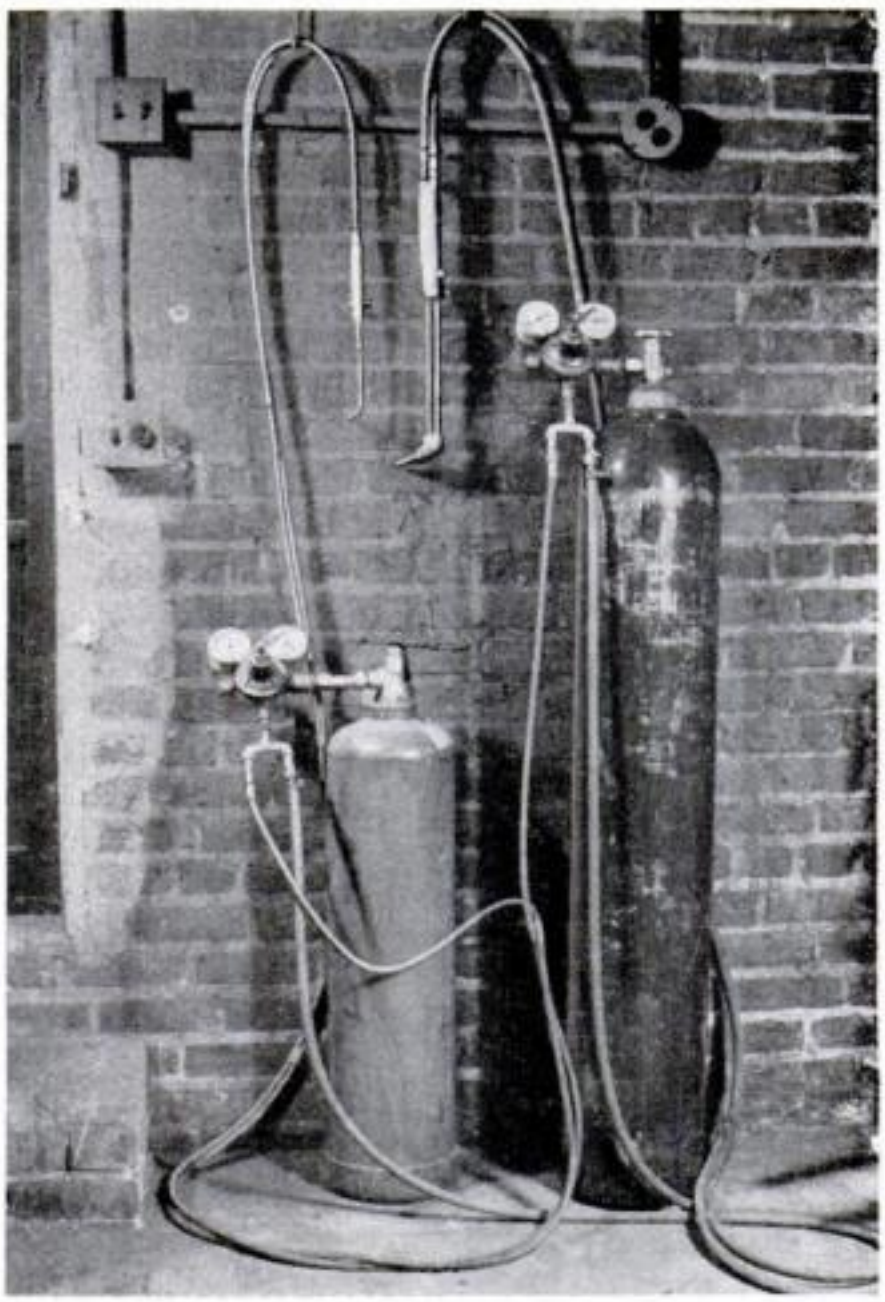
MOST types of broken or worn-out automobile or truck crankshafts can be converted into convenient bench anvils with little trouble. With a cutting torch or power saw, cut the flywheel end of the shaft off at the first crank, and dress the cut smooth on an emery wheel or with a file. The flange forms a solid base for fastening the anvil to the workbench.—CHARLES H. HARDY.

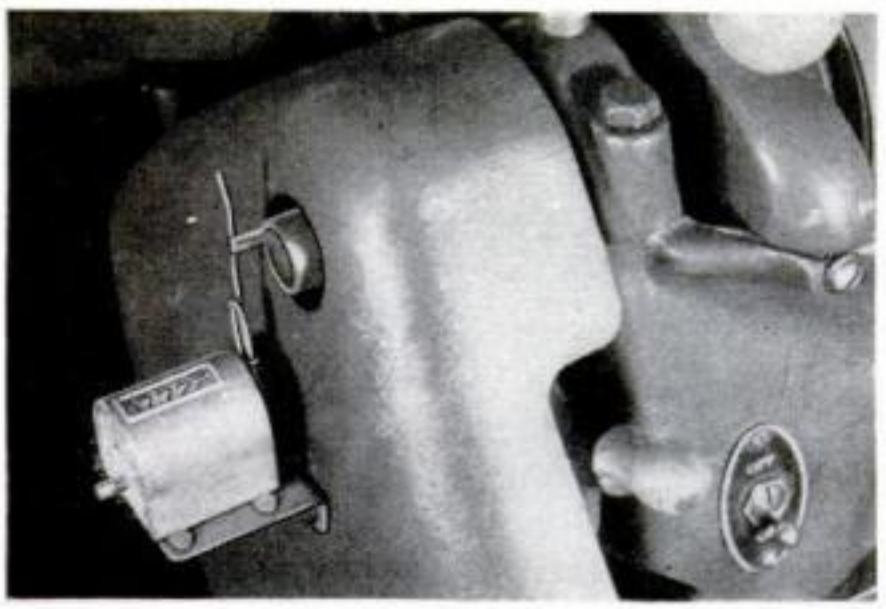
Taper Pins Ground in Hand Drill

ODD-SIZED taper pins can be ground to shape from drill rod by rotating a piece of the required length in a hand drill against a grinding wheel.—FRANK NAVRATIL.

Double Hose Connection Saves Time in Gas Welding

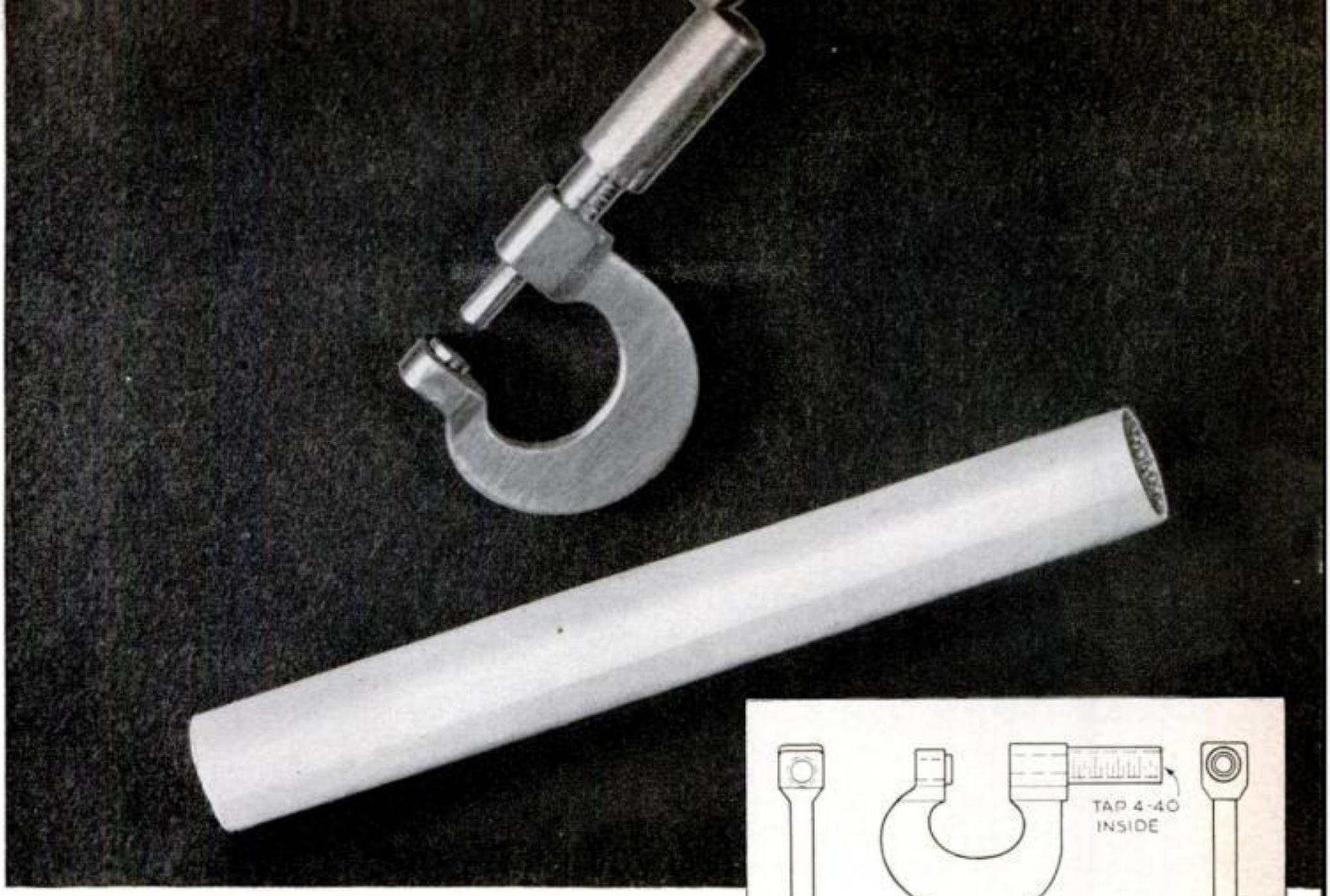
IN A SMALL shop with one acetylene torch, time and gas are wasted in changing from welding to cutting torch or from one size torch to another. Often a job calls for a certain piece of material to be cut and welded in place before a second is worked on. A double hose connection on each regulator will enable the mechanic to lay down his cutting torch and immediately use the welding torch by simply changing the pressure. Care should be taken to use litharge and glycerine on connections and not oil. The pipe fittings are ⅛".—PERRY HYAMS.





Revolution Counter Mounted Permanently on Lathe

A SMALL counter, mounted permanently on the gear cover of a screw-cutting lathe, is convenient for coil winding and similar jobs. A short piece of brass pipe or tubing to fit into the spindle is cut so as to leave a short stub on one side to trip the counter at each revolution. When not in use the pipe is pulled out of the spindle, and the counter spring keeps the arm clear of the hole, so that the counter may be left in place.



Watch-Charm MICROMETER

A Midget Measuring Instrument That Actually Works

AN IDEAL hobby project for machinists and other craftsmen, this Lilliputian micrometer will arouse the interest of all who see it. Only a few hand tools are needed to make it, yet if carefully constructed, it can be used to gauge sheet metal, wire, and small parts with reasonable accuracy.

Saw out and file the frame, including the sleeve, to shape from ¼" flat steel. Dimensions can be taken directly from the full-size drawing on this page. File the sleeve perfectly round, or turn it so on a lathe. Run a No. 43 drill through both the sleeve and the anvil end. Tap the sleeve with a 4-40 thread.

For utmost accuracy, the spindle thread should be a close fit. Shoulder down the two ends, either in a lathe or by filing in a revolving drill chuck. The thimble is a piece of brass rod, drilled to fit over the sleeve for most of its length and lightly knurled or crosshatched on the outside. Bevel the open end and drill a 5/64" hole through the closed one. Insert the spindle. Rivet it over lightly, and file smooth. Turn or file the anvil from a small piece of steel rod and rivet it securely in place.

Polish with fine emery cloth. Markings can be engraved or etched on the sleeve and thimble collar.—J. W. LAWRENCE.

$25 IN CASH PRIZES FOR MINIATURES

For the sake of a little friendly competition among readers, we will give a first prize of $15 and two other prizes of $5 each for the three best handmade miniatures of any type submitted on or before May 1, 1942. Send the model itself or, if you do not want to part with it, submit one or two clear photographs. The miniature must be something you have designed and made yourself and it should not be larger than 1½" in its greatest dimension. No entries will be returned . . . the editors will be the judges and their decision will be final . . . duplicate prizes will be awarded in case of ties. Address Miniature Contest Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, N. Y.

TWIN WATCHDOGS OF HOUSE WIRING

Grounding and Polarization

By HAROLD P. STRAND

MY NEIGHBOR Jim wasn't careless that time he tried out his new photographic safelight. He first made sure the socket switch was turned off. Then he carefully inserted the plug of the safelight into the socket shell, fumbled just a little as the thread refused to catch, and—Fizz-zzz! A startling burst of electrical flame—the acrid odor of hot metal. Something fell stingingly on his hand. Small wonder that he jumped back, dropping everything.

When his heart stopped pounding, he found the safelight was smashed, a piece the size of a nailhead had been melted out of the ferrule on the plug and another out of the socket, and he had a painful little burn on his hand.

"But I don't see *why*," he muttered as he cleaned up the mess. "I *know* that socket was turned *off*."

Many mysterious mishaps such as this result from lack of proper grounding and polarization, which is particularly hazardous if circuits are overfused (see P.S.M., Feb. '42, p. 195). In the case described, which actually occurred, the socket screw shell was wrongly connected to the "hot" instead of the grounded side of the line. This live wire was therefore not controlled by the socket switch at all! As the paper liner between screw shell and outer casing was slightly frayed at the edge, the safelight plug momentarily touched both these parts, causing a dead short.

Do you get a tingling from your workshop motor or lathe when the cellar floor is damp? Possibly insulation has broken down somewhere in the machine, which is not properly grounded. Must you beware of touching the bathroom light chain when turning on a faucet? Then look out for a defective and improperly wired socket—and bad shocks!

The National Electrical Code requires that all new wiring, with few exceptions, be grounded and polarized in an approved man-

Fig. 1. Ten common types of wires and cords; all have identifiable conductors

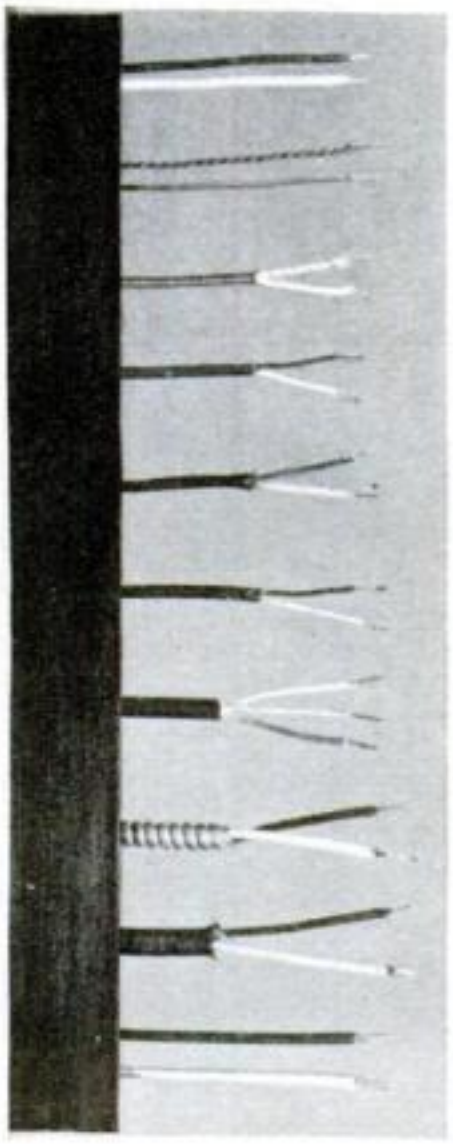
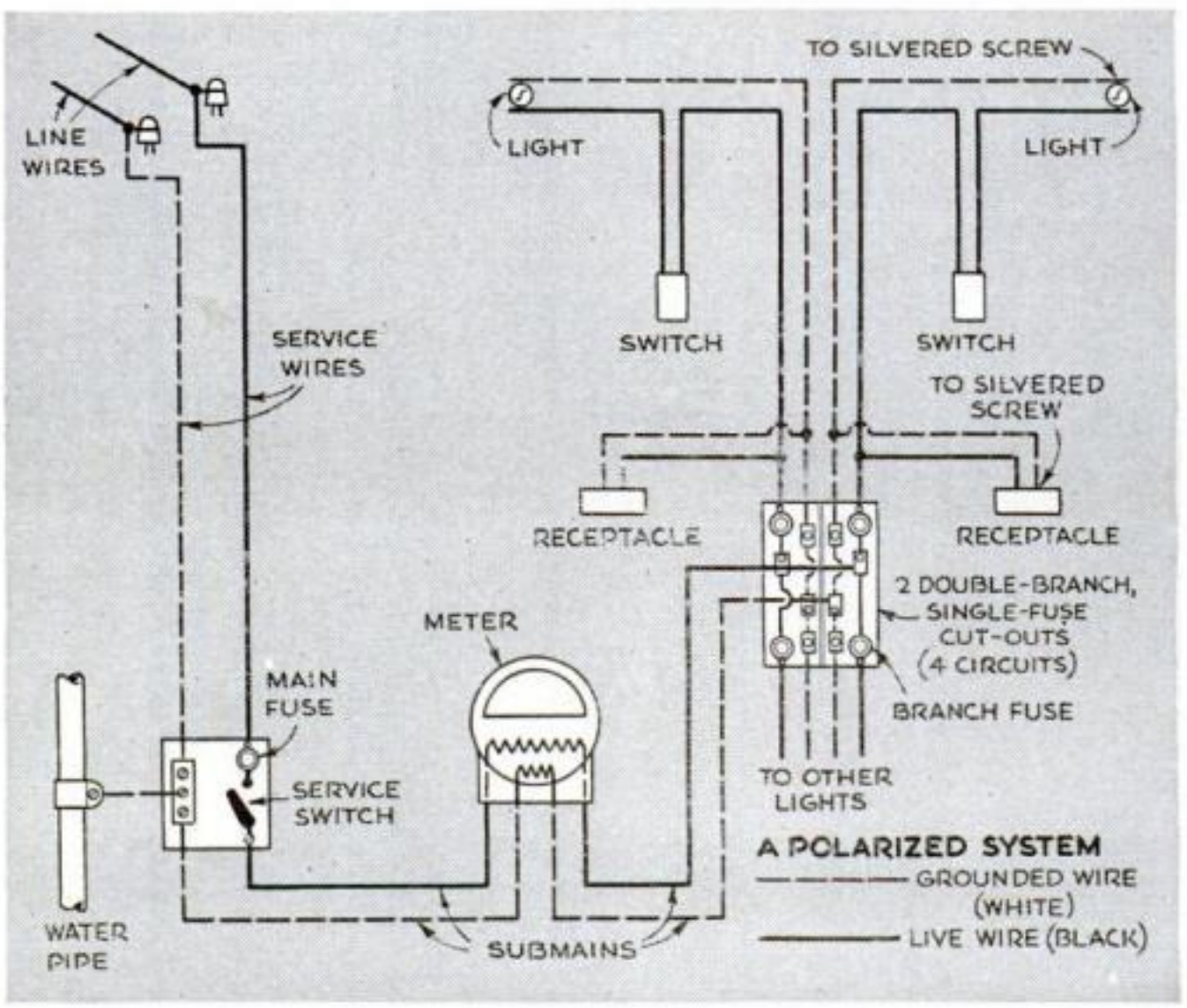


Fig. 2. A typical polarized system. The grounded (white) wire is continuous. Switches and fuses may be cut into the live (black) wire only. Conduit or BX armor, cabinets, boxes and fixtures are all interconnected and grounded



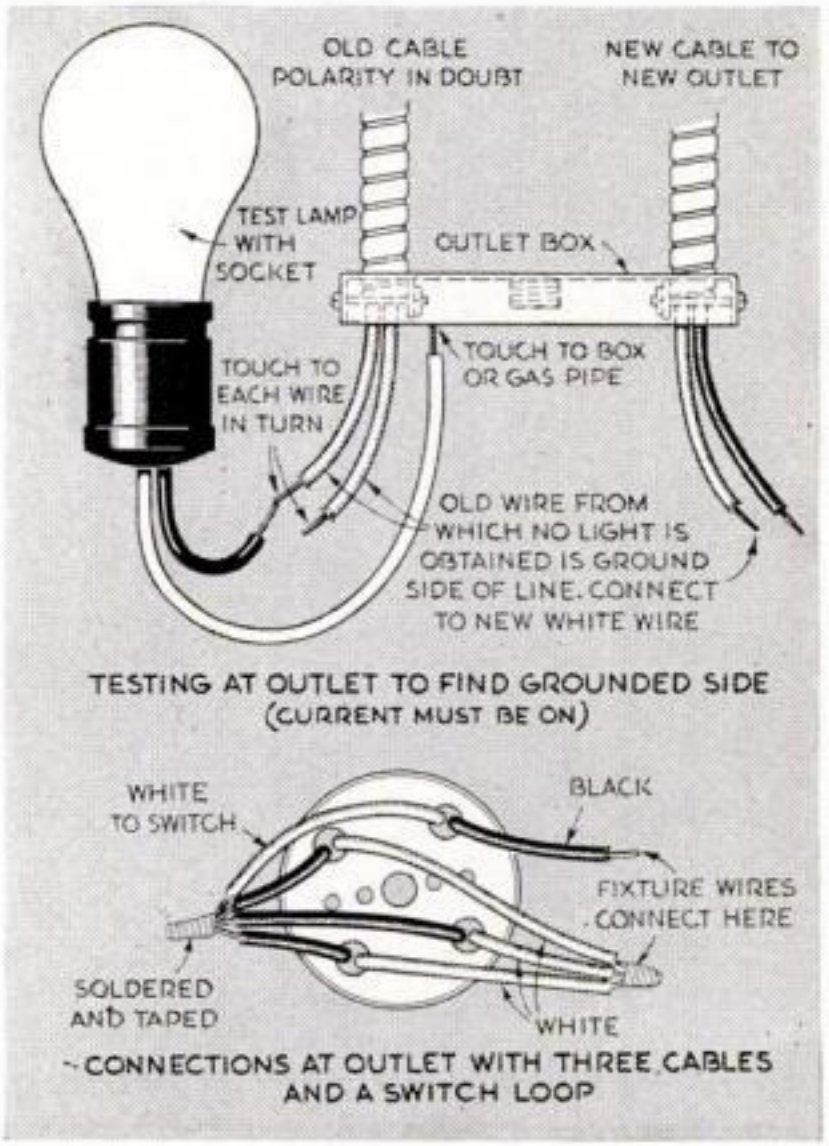
Polarization is especially important in outlets near grounded objects or in damp locations. The use of porcelain or composition fixtures affords additional protection against shocks

ner. This means that one of the conductors is grounded, usually at the service entrance, and marked or colored so that it can be identified at any point in the system (see the photograph marked Fig. 1). A wire with white or gray covering is standard for this purpose. The ungrounded or live wire or wires are usually black. No switches or fuses may be cut into the white wire anywhere; its continuity must be uninterrupted, as shown in Fig. 2. All metal cabinets, boxes, conduit, BX armor, and fixtures are interconnected and grounded.

To insure correct polarization, the grounded wire of a polarized system must be connected to the *screw shell* of every socket—that is, under the silvered screw. Fixtures are usually wired with

Fig. 3. Joining the tracer wire from a fixture to the white conductors with a solderless connector. The plain fixture wire goes to the black side of the switch loop

Fig. 4. How to test unidentified conductors for polarity and, below, connections of three cables and a switch loop inside an outlet box



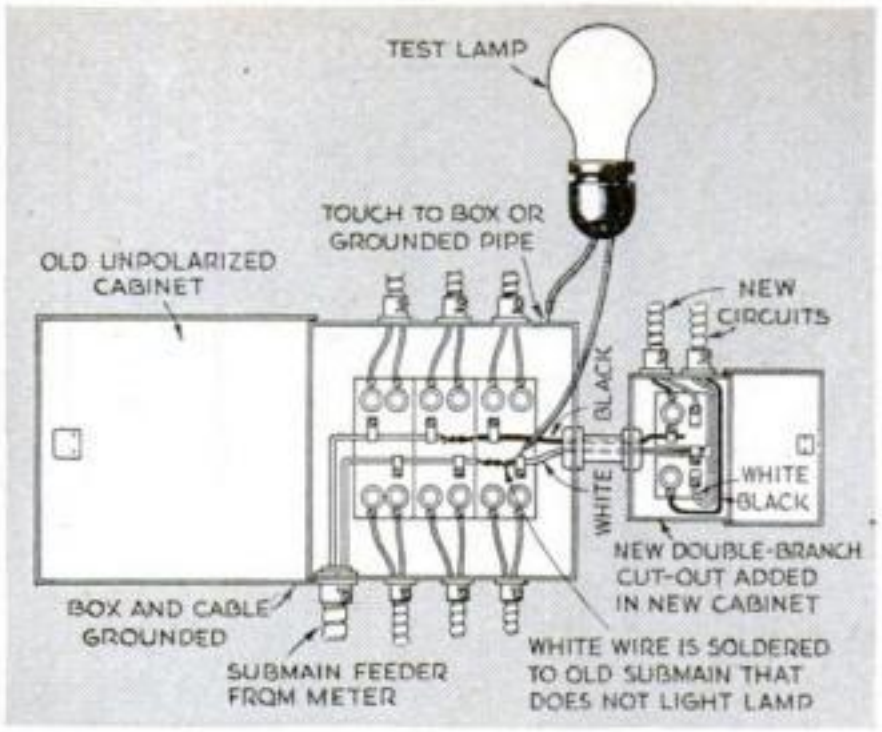


Fig. 5. An extra cut-out cabinet may be added as above. Use a test lamp to establish the polarity

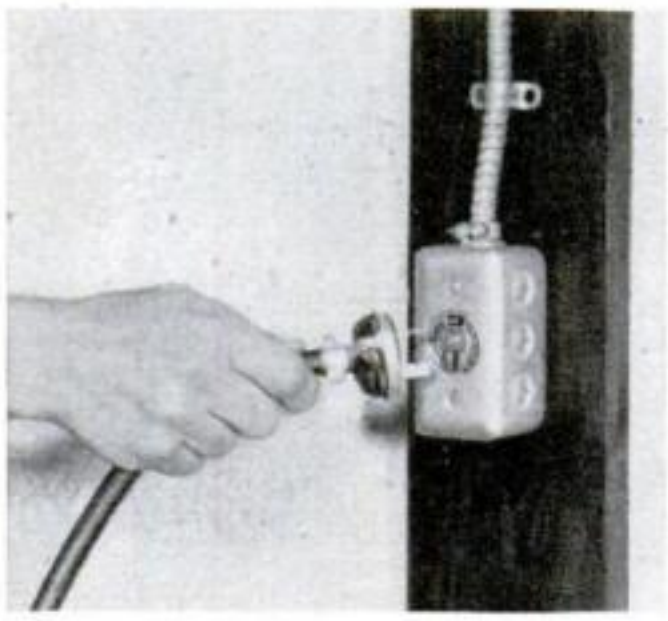


Fig. 6. Above, a special plug and receptacle will maintain the polarity of a cord-connected appliance. Such a plug can be inserted in only one way

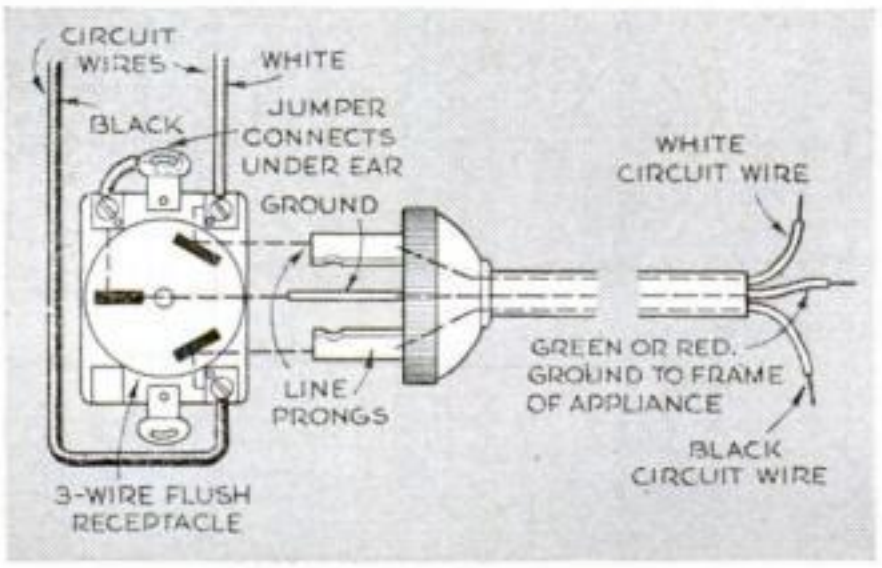


Fig. 7. Three-wire plugs and receptacles maintain polarity and will also ground portable equipment

flexible leads, either with one plain and one tracer wire, or else with one white and one black wire. The tracer-marked or white wire is to be connected to the white circuit wires at the outlet and the silvered screws of the sockets (Fig. 3). Switch loops are cut in series with the black side and the plain fixture wire (Fig. 4).

In wiring systems using armored conductors such as BX cable, the outer sheath of which can be grounded, fixtures also are grounded by attaching them to the outlet boxes with "hickeys" or other conducting devices. However, in knob-and-tube systems or those wired with nonmetallic sheathed cable, the grounding of fixtures may be difficult or impossible. To minimize shock hazards in such systems, unless the fixtures can be grounded to a nearby gas or water pipe, it is well to place them out of reach and control them by wall switches. Another good idea is to use porcelain or composition fixtures where possible. It is well also to use such fixtures with any wiring system in the bathroom, laundry, and cellar, and near sinks or stoves, and to control such fixtures from wall switches whenever possible. Be especially careful that the grounded side of the line connects to the screw shells of the sockets.

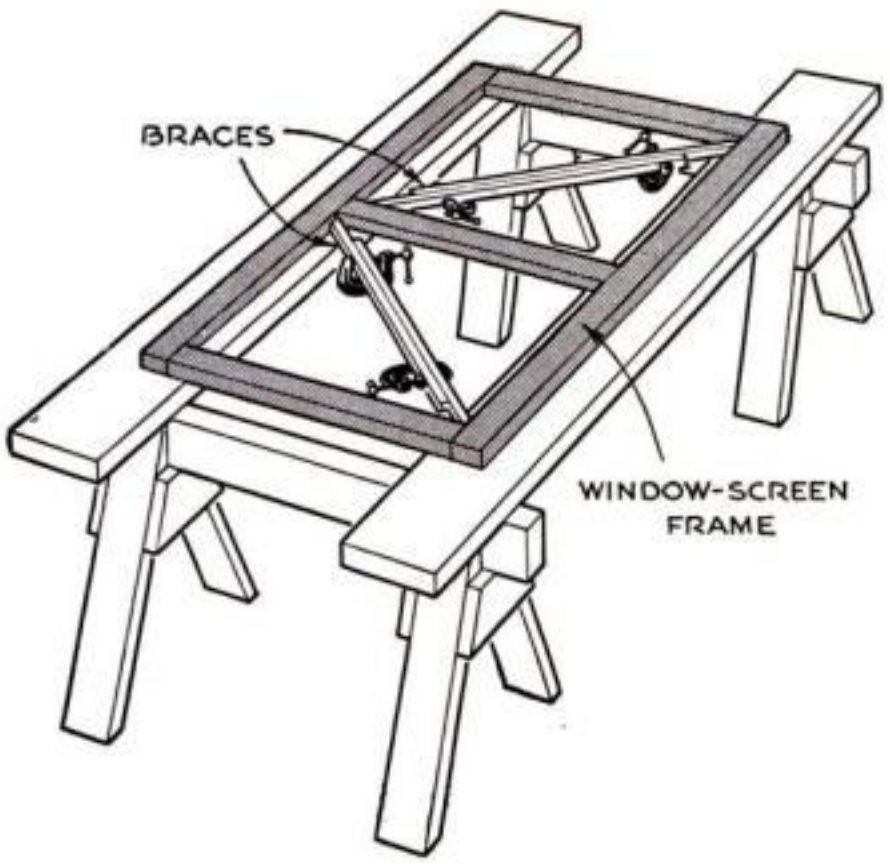
If a metal pull-chain socket has to be used over a sink or anywhere near pipes, radiators, or other grounded objects, put an insulating link into its bead chain.

When extending wiring from an existing outlet to a new one, take care to maintain polarity by making all splices white to white and black to black, and cutting switch loops in series with the black side. If in doubt, you can test old outlets for polarity. This is done with a lamp and socket equipped with two insulated leads as shown in Fig. 4.

It may be found, when a new circuit is to be added, that an additional cut-out cabinet is needed. This is joined to the old one with a conduit nipple, lock nuts, and bushings, and connections are made, following a test, as in Fig. 5. To make sure that the grounded side is attached to the silvered terminals in the new box (which are not fused), the test lamp is used as before. Splice the new white wire to the old grounded submain and solder the splice, which should be located between terminals in the groove. The black wire is spliced to the other or live submain. Sometimes new wire can be run through both cabinets to the meter, eliminating splices.

In the case of lamps and other portable cord-connected appliances, polarity cannot be maintained because the cord can be plugged in either way. On common household accessories this is usually overlooked, but where it is desirable to maintain polarity, special receptacles and caps such as shown in Fig. 6 should be used. These plugs can be inserted in only one way, therefore the screw shells can be grounded.

Another method of polarizing portable equipment, especially suitable for appliances used in damp locations, is illustrated in Fig. 7. This is a three-wire receptacle and cap. Two wires carry the current and the third one grounds the frame of the appliance.

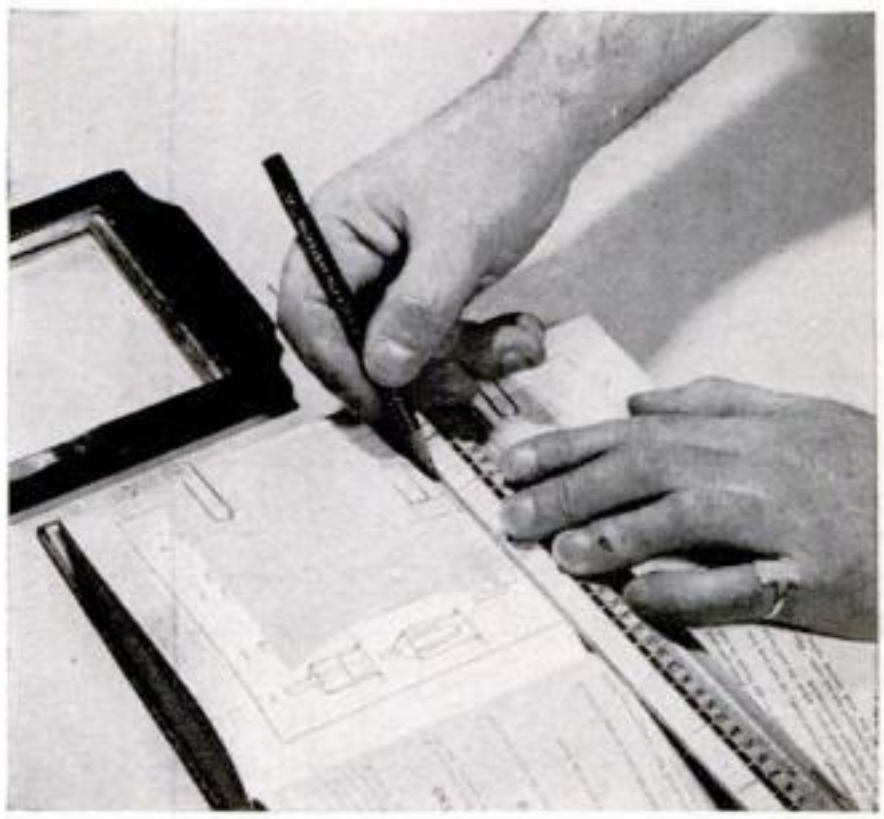


Braces Keep Frames in Shape as Screening Is Tacked On

IN STRETCHING wire insect screening on a large, lightly constructed frame, it is easy to pull the latter out of shape. This can be avoided by first placing the frame in the opening it is to fit and inserting a diagonal brace in each section. Each brace consists of two pieces of wood slightly shorter than the diagonal, clamped together where they overlap with two small C-clamps. The frame can then be laid on planks as shown and the screening tacked on. If the ends of the braces are allowed to rest on the planks, they cannot fall out.—ARTHUR KOEHLER.

Working Drawings Enlarged by Projection Method

IF A PHOTOGRAPHIC enlarger is available, small-scale drawings in a magazine or book can be enlarged to any required size. First trace the original drawing on a piece of translucent or onion-skin paper. Use this tracing as a negative in the enlarger and project the lines on a sheet of drawing or wrapping paper so that they can be retraced in the larger size. With an enlarger which permits control of distortion, it is also possible to alter the perspective of sketches or make caricatures.—K. M.

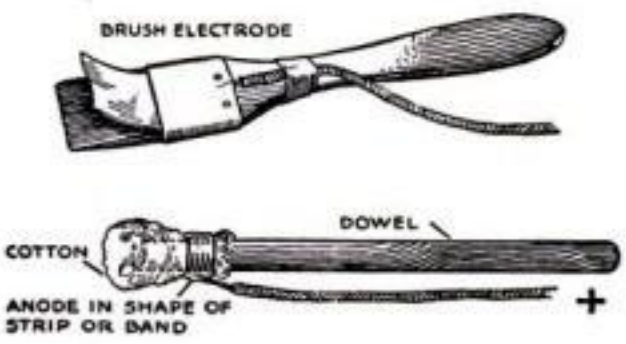


Tracings on onion-skin paper may be projected in an enlarger and retraced to get larger drawings

ELECTROPLATING, PART 10 [ELECTRICAL]

Brush plating is convenient for touching up worn spots on old plating and for treating work that cannot conveniently be placed in a tank. By means of a suitable applicator in contact with an anode, the plating solution is flowed over the work and deposits metal in a more or less uniform film, the thickness of which depends upon the usual factors of time and current.

Two simple applicators are illustrated. One is a brush with rubber-set bristles, the metal ferrule of which is replaced with one formed of the plating metal. The other applicator is a clean wooden dowel to which a tuft of cotton is held with a band of anode metal. Two 1½-volt dry cells in series furnish the current, making the outfit portable. One cell is, indeed, enough for plating with nickel. The usual solutions are suitable but are best used in more concentrated form. Add a little gum tragacanth to thicken them for easier handling.



An application of oil-free metal polish and buffing with a clean cloth is usually enough to clean the work. Connect the brush anode to the positive side of the battery and the work to the negative. Thoroughly wet the brush with electrolyte. Flow this over with even strokes until the plating is thick enough, keeping the brush well filled with solution. Wash the work immediately after the plating is finished.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

MODEL-RAILWAY NOTES:

Yard Tracks

By DAVID MARSHALL

Author of *Model Railroad Engineering*

ENGINEERING books tell us that a yard is a sidetrack, or a system of sidetracks, intended (1) for storage of idle equipment, (2) to facilitate making up and breaking down trains, and (3) for loading and unloading freight. The practical railroad man tells us that a yard is any track on which wheels may run without train orders. This definition emphasizes the difference between yard and main-line trackage, for "the line" is high iron and a yard is not.

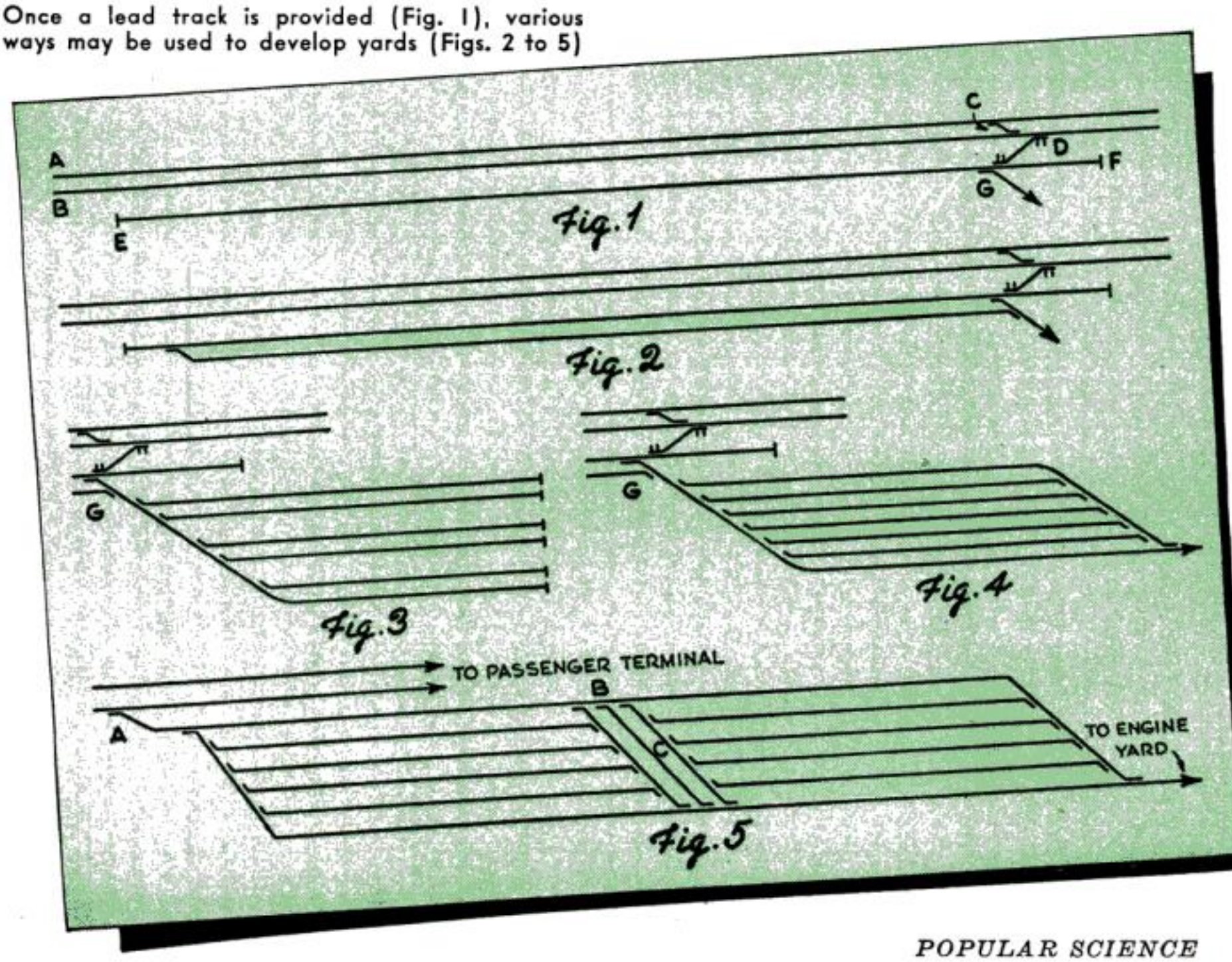
The laws of the road forbid any train or locomotive to venture onto high iron without permission of the dispatcher. Yards are outside the dispatcher's jurisdiction; they are low iron and free trackage.

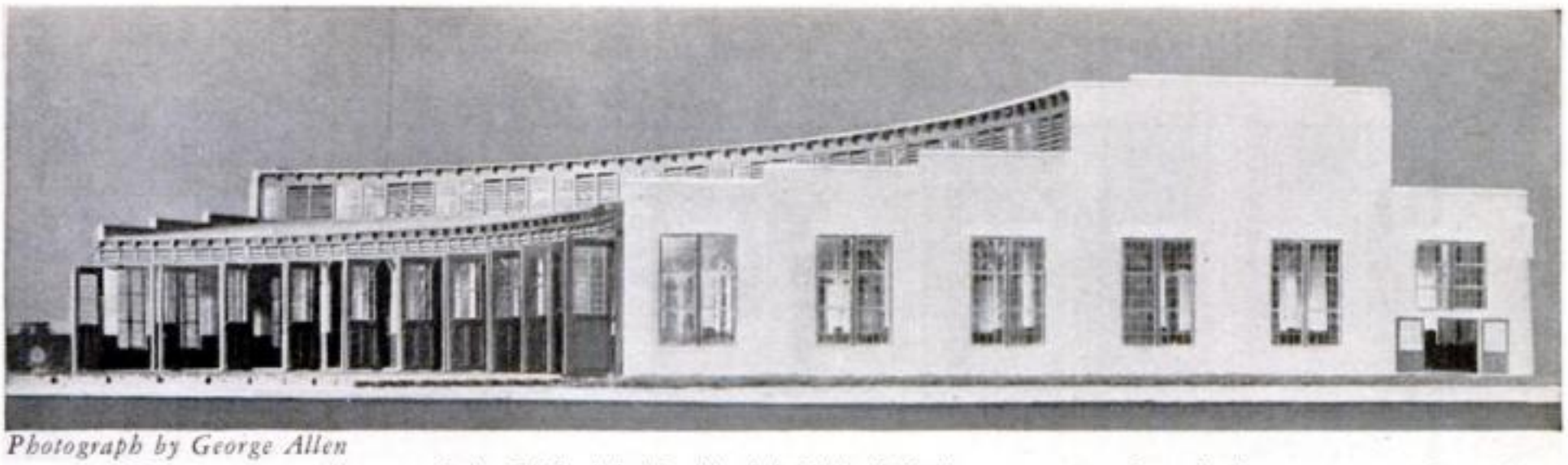
We can therefore say that every yard must lie wholly on one side of your main line; that no main-line track may form any part of a yard, and no yard track may form a permanent part of the main line.

LEAD TRACK. This vestibule that leads to high iron is the one essential of every yard. On most pikes it serves as receiving track, drill track, and departure track. One rule is hard and fast: Your lead track must be a few inches longer than the longest train that will ever enter the yard.

From the bumper at *E* in Fig. 1 to the turnout switch at *G*—this is the lead. *A* and *B* are the main-line tracks. *C* is a crossover, laid with *trailing* points in the high iron so that every passing train runs through it from the rear. *D* is the crossover that links the yard and the big pike, and this, too, is built so as to trail into the *B* track. *C* requires no explanation, and if both switches are *sprung open* (see P.S.M., Jan. '42, p. 185), it will hardly ever require attention. But the switches of *D* are interlocked, so that both must open and close together. Normally they remain closed, and they can be controlled only by

Once a lead track is provided (Fig. 1), various ways may be used to develop yards (Figs. 2 to 5)





Photograph by George Allen

O-gauge roundhouse of the Philadelphia Model Club. Windows consist of real glass panes set in putty

the dispatcher or the nearest towerman, who is the dispatcher's local deputy. The gates of *D* will never open unless a train is waiting on the lead track to leave the yard, or on the *B* track to enter the yard. When it has done so, the gates will close again. As long as the gates of *D* are open, *the entire lead track becomes high iron.*

Normally, with *D* closed, the lead track is part of the yard, insulated from the main line by *D* and by two tipping devices, one at *E* and the other at *F*. At *E*, the western end of the lead, we have a bumper. But as the track approaches the bumper, the north rail is sharply elevated, so that if any equipment should slip out of control and run wild westward, and should strike the bumper with such force as to cause it to leave the rails, it will be pitched over to the south, away from the main line. The extension of the lead track eastward beyond *D* is called the safety point. It provides a runway and a southward tip at the *F* bumper for equipment spinning out of control in an easterly direction. The safety point must be long enough to accommodate your longest locomotive.

Finally, *G* is a simple turnout switch from the lead to the main body of the yard, which may be of any type.

RUN-AROUND TRACK. Obviously, a train from the west would back into the lead track shown in Fig. 1. Then, as soon as the gates were closed again, her locomotive would uncouple and proceed at once, via *G*, to the engine yard for servicing, while a yard goat, previously stationed on the safety point, would immediately take over and distribute the cars through the yard. But a train from the east would back through *C*, then pull forward onto the lead track—in which case her locomotive would be trapped near *E*. To provide against just this, we add to the layout shown in Fig. 1 what is called a run-around track (Fig. 2). This will also enable a road engine to go to the head of a westbound train the yard goats have made up. It also enables yard goats to work both ends of a train at once. And between times it can serve for storage.

LADDER TRACK. The track out of the lead at *G* must distribute equipment to various other yard tracks. So, it's likely to be a ladder track. In Fig. 3, three pairs of stub tracks "step off" the ladder. A stub track is one that terminates in a bumper. As they are paired off in the sketch, they are obviously used as team tracks (on which cars are "spotted" for loading from or into motor trucks). And a house track is only a stub track which serves the loading platform of a freight house.

DIAMOND. It often pays to have storage tracks open at both ends, especially in a coaching yard—one intended for the storage of passenger equipment. And so, uprooting the bumpers in Fig. 3 and splicing in another ladder track, we arrive at a diamond (Fig. 4). Within the diamond any number of body tracks may be constructed parallel to the two outer or rim tracks. Body tracks are available for storage purposes, but ladder tracks and rim tracks must always be kept free.

DOUBLE DIAMOND. If you have space enough for a double diamond, you can make a splendid freight terminal. Little more would be needed—a few team tracks, a house track, and a bad-order track on which to spot crippled equipment. Rims and ladders would take the place of lead tracks and run-around. An incoming train, entering via the crossover at *A* in Fig. 5, would run halfway along the north rim to the switch at *B* and pass to the south rim via the center track *C*, between the two ladders. We call that track the caboose track. There the incoming train drops her caboose, while an outgoing train, waiting on the east ladder (and the north rim east of *B*) gets under way. After clearing *B*, she halts a moment. A yard goat moving up the *C* track then pushes the caboose out upon the rim and couples it to the train.

Waterproof

By MAURICE WHARTON

PAINTS that are prepared for use simply by adding water, that anybody can apply over almost any type of surface, that dry in less than an hour, and withal are permanent and washable, sound like a home planner's dream. Nevertheless, they are very much a fact, widely used by interior decorators and deservedly popular.

These paints are available in white and pleasing pastel shades such as ivory, gray, tan, blue, orchid, and coral. Brilliant "fresco" colors can be had for mixing in-between shades, painting on stencil designs, and creating special effects. Beautiful modern treatments such as broad gradated bands of a single color shaded from the pastel tint to its deepest tone, known technically as "let-downs," are possible by progressive mixing. One such effect is illustrated above.

A possibility not to be overlooked is the creation of stunning backgrounds for color photography. The amateur photographer, by using inexpensive wall-board panels and water paints, can make a variety of color screens and background sets.

These comparatively new water paints come in both powder and paste form. In general, they all possess the same properties of quick drying, clear colors, very flat finish, ease of application, and freedom from strong afterodor. Interior water paints can be applied directly to plaster—even when it is still slightly damp—as well as over brick, wall board, wood, metal, wall paper, and oil paint. Exterior finishes of this type may be used on brick, concrete, stucco (except magnesite), and other painted or unpainted surfaces. Because priming coats are rarely needed, and because water paints are applied with wide brushes, they afford a very

economical means of finishing. However, they do not bond perfectly to glazed surfaces such as some types of tile and brick, nor should they be used for finishing rooms subject to steaming, such as bathrooms, kitchens, and laundries. Oil paints or enamels are preferable for such purposes, and worth the difference in cost.

The casein powder type of water paint is usually a mixture of dry casein, hydrated lime, and pigment. It should be allowed to stand for 20 or 30 minutes after mixing before it is applied. This type of paint is especially suitable for covering damp surfaces containing strong alkali, such as green concrete or fresh plaster.

More recently, water paints have been developed in paste form. These include casein, soybean protein, and resin paste paints. The casein paste paint contains pigments of great hiding power, such as lithopone and titanium dioxide. It is easily brushed on, dries quickly, and provides a very attractive flat pastel finish, which may be cleaned with a sponge and a mild soap solution.

Soybean paste paint, in which soybean protein serves the same purpose as casein, has an even cleaner odor. It is also easier to preserve and is claimed by some experts to stand up slightly better on damp walls. Some water paints combine casein and soybean protein, and the advantages of both.

Resin paste water paint, which is another variety, is prepared for use by adding half a gallon of water to a gallon of the paste. It consists of what are called "alkyd resins," emulsified into water, usually with a small amount of protein to stabilize the emulsion, and suitable pigment. The advantage of resin paints over casein and protein paints is that, when they dry, the resin is highly water resistant. Such paints will withstand a surprising amount of washing and scrubbing, being comparable in this respect to flat oil paints. They are especially suitable for covering alkaline surfaces, such as green concrete or fresh plaster.

For outdoor use two coats give a sufficiently thick film to withstand weathering. A good outdoor resin paint, properly applied, will last several years and present an attractive finish during this time. These paints are "self-cleaning," in that they chalk off at a very slow rate, and rain washes off surface dirt along with the fine dust.

To mix resin paste paint, use only clean galvanized iron buckets. Add water only as fast as the paint can take it up, stirring thoroughly. In cold weather, mix outdoor water paints with warm water. If freezing temperatures prevail, use a half-and-half water and alcohol mixture.

Calcimine and whitewash must be thoroughly removed before modern water paints are applied. Glossy or greasy surfaces on which the paint "crawls" should be scoured with washing powder before painting. Where plaster flakes, chalks, or shells easily, brush off all loose material and apply a flat, pigmented, oil-type wall size. Casein size is also satisfactory, but glue, water sizes, sealing varnish, and shellac are not suitable for use under water paints. Surfaces that have been treated with alum or zinc sulphate, or with sizes containing these substances, must be washed with a strong washing-powder solution. Where effervescent mildew, acid, or excessive dirt and grease conditions exist, a trisodium-phosphate wash is advisable, followed by a water rinse. It is not necessary to wait for the surface to dry before starting to paint. In preparing old surfaces, fill all holes or cracks with patching plaster. Give patches a preliminary coat of the finishing paint.

Outside surfaces should be clean and free from dirt, dust, or grease. Remove old cold-water paints or whitewash. Clean off oil or grease with gasoline. Use a scraper or wire brush to remove any rust or loose, scaling materials. Hard rust spots and metals susceptible to rust should be primed with a rust-inhibitive paint. Point up holes and cracks with suitable patching material and coat these spots before painting all over.

No surface preparation is necessary when painting new concrete, stucco, limestone, and masonry surfaces. Do not neutralize lime before applying the paint. However, if an acid wash has been applied, it will be necessary to neutralize this acid with an alkaline solution. Caution should be exercised

Water Paints
give lasting color beauty

WHAT ONE GALLON OF PASTE WATER PAINT WILL COVER

Kind of Surface	Square Feet (one coat)
Previously painted	700-750
Finish-coat plaster	500
Concrete	400
Brick	250-350
Insulating board	200-225
Concrete block	200-350
Sand-finish plaster	175-250
Cinder block	150-175

when painting reclaimed brick, improperly kilned brick, or mortar joints made with unwashed sand. The paint will not form a proper bond with any powdering brick, cement, or limestone surface.

Deeply embedded, bleeding stains become visible after the first coat of paint and should be sealed before applying a second coat. Be sure that roof flashings, gutters, cornices, and the like are in good condition before starting the paint job.

A good, clean calcimine, Dutch calcimine, or large paintbrush with soft, flexible bristles is suitable for applying most water paints. Keep the brush well filled at all times.

If the paint becomes too thick during application, it may be thinned by the addition of a small amount of water. One coat will be satisfactory in many instances, but on new surfaces and on surfaces where extra durability is desired, two coats are recommended.

Allow the first coat to dry at least four hours before applying the second one. In other cases, provided that there is sufficient ventilation to speed evaporation, pictures and furnishings may usually be replaced within an hour after painting.

Contrary to general belief, white and such light tints as buff and cream have the highest one-coat covering efficiency.

Immediately after use, all brushes should be cleaned in a soap solution. If brushes have been allowed to dry with the material on them, they can often be softened in benzine.

Do not attempt to wash water paints until they have been on the surface at least 30 days. After this you can brush or sponge the surface with a mild soap solution, washing the latter off with clean, lukewarm water immediately after it has been applied. Start washing at the floor and work up to the ceiling. Wall-paper cleaner gives excellent results and is especially recommended where the paint has been applied to a porous surface. Do not attempt to scrub casein and soybean protein paints.

WATER PAINTS AND THEIR USES [PAINTING]

Type of Paint	Where Used	Kinds of Surfaces	Preparation of Surfaces
Calcimine, whitewash, other glue-bound water paints	Walls and ceilings of living rooms, dining rooms, bedrooms, halls, basements	Use only on surfaces not subject to dampness. Plaster, wall board, wall paper, primed wood, old painted surfaces	(a) Remove old calcimime. (b) Ordinarily no primer is necessary. (c) Surface should be clean and dry. (d) Plaster of uneven porosity requires oil- or water-type priming coat
Casein and casein-soybean paints	As above	Where normal conditions prevail, but where maximum washability is not expected	As above
Resin paints, interior type	As above	Surfaces subject to moisture or that must be washed frequently.	As above
Resin paints, exterior type	Exterior walls	Where surfaces are subjected to dampness, rain or snow. Brick, stone, concrete, concrete block, asbestos shingles, and old painted surfaces	See that surface is clean and free of dust
Cement powder paints	Interior or exterior walls	As above	Surface should be damp during application

Note: All types of paint are reduced with water according to the manufacturer's directions. They are applied with a brush, but may be sprayed if suitable equipment is available.

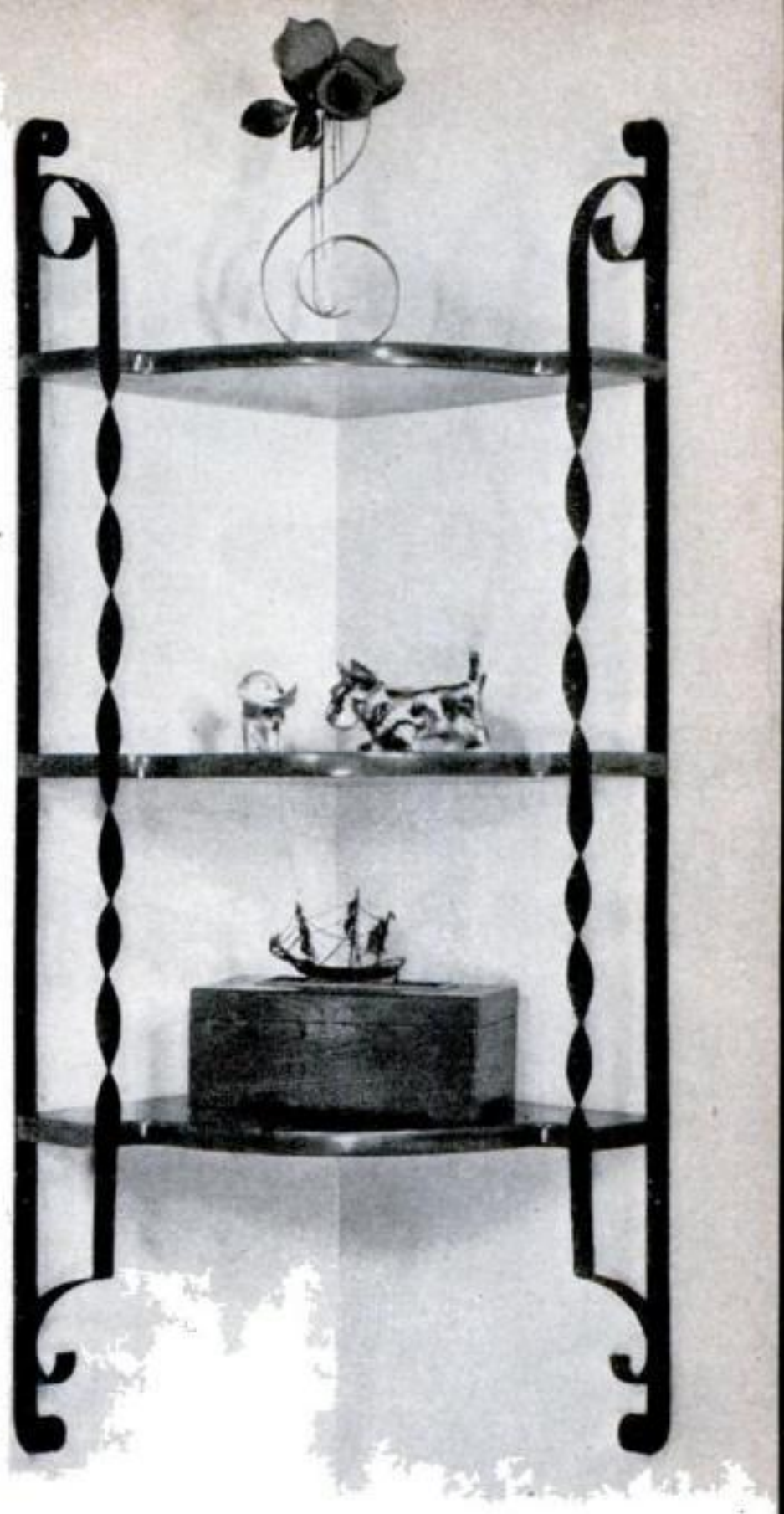
POPULAR SCIENCE MONTHLY SHOP DATA FILE

Corner Shelf

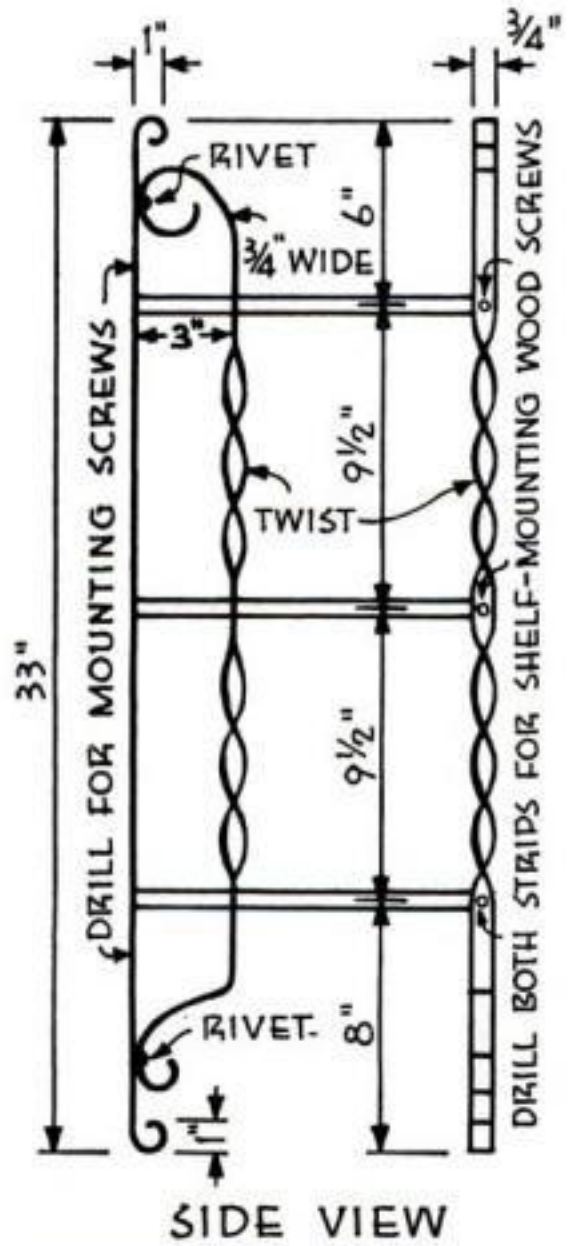
ALTHOUGH wrought iron is the ideal material for the supports of this corner shelf, they were actually made of scrap banding—the 1/16" thick galvanized strips that are bent around bundles of galvanized-iron sheets for shipping purposes. Many tinsmiths will sell it for a small sum. In this case it was bought for the price of machine-cutting the strips, which are 1½" wide, to ¾".

All bends are made cold. After forming one end of each front member, fasten the stock upright in the vise, formed end up. Grip the upper end between the jaws of a monkey wrench, or between two iron bars clamped together, and carefully twist through two full turns. Measure the distance between the vise and the upper clamp before twisting, and note it down for use in making the second member. The strip is then reversed in the vise and the second twist made in the same way, after which the other end may be formed. Sight along the piece and straighten it after twisting.

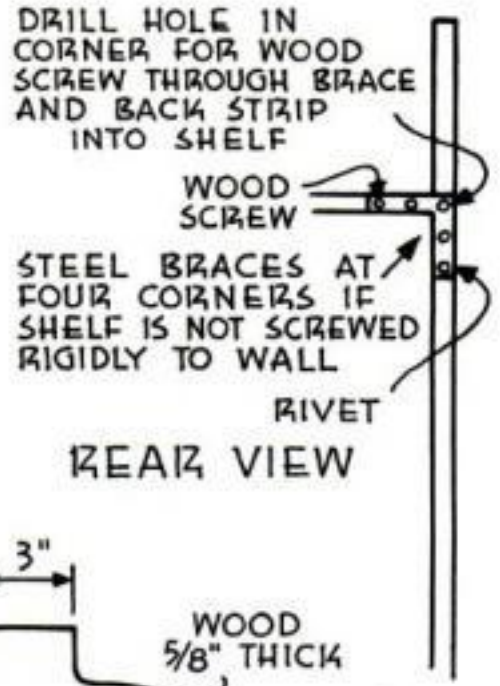
The remainder of the construction is shown in the drawings. The metal sides may be finished in a flat black especially made for wrought-iron work, and the shelves stained and varnished; or, to suit various color schemes, the entire piece may be enameled in colors.—HARRY WALTON.



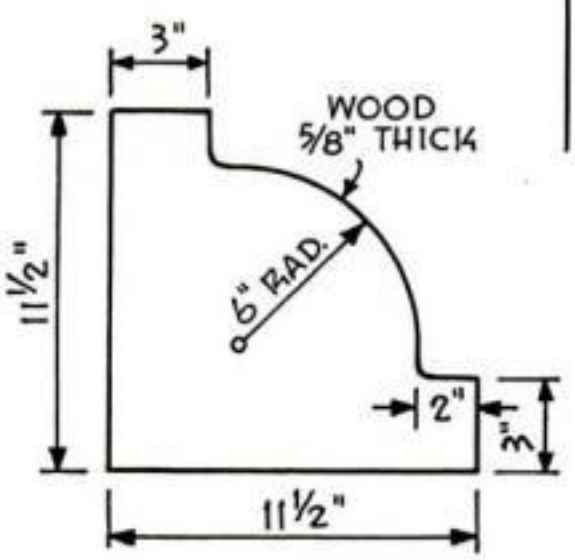
Big, roomy shelves are a feature of this design. As the edges are prominent, solid wood is preferable to plywood, unless an opaque finish is used



SIDE VIEW



REAR VIEW



SHELF PLAN

Fasten the shelves to the supports with wood screws. Greater rigidity is obtained by using four angle brackets in back as shown in the drawing

Clocked Project

Average Time
6 hours

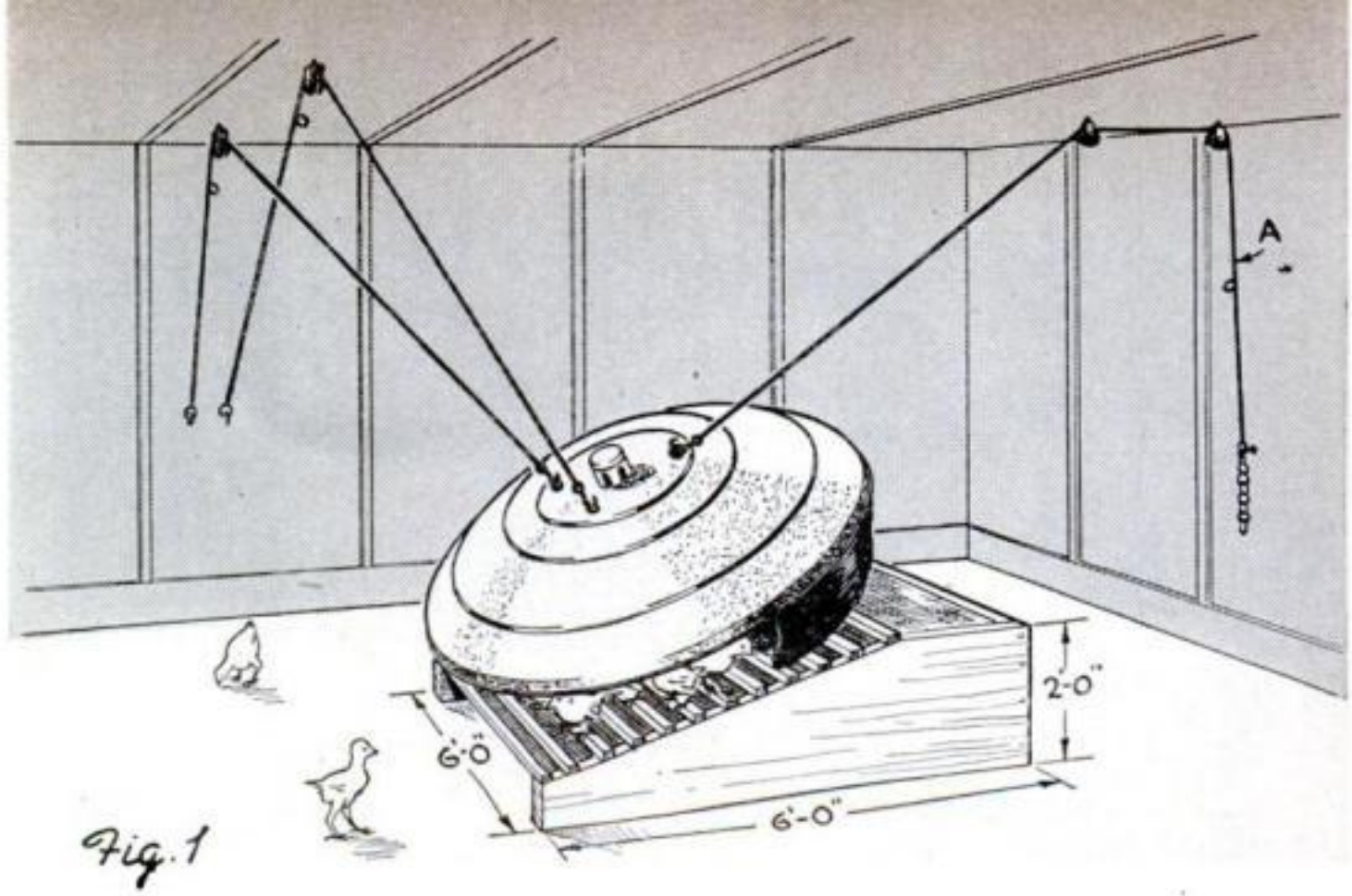


Fig. 1

Mortality from crushing is much reduced if chicks roost early. By suspending a hover as explained below, one poultryman trains them to roost in six weeks

Training Chicks to Roost

By JOHN DONNELLY

IN RAISING chicks it is difficult to prevent them from huddling together on the floor and crushing one another to death. Mortality from this cause may mean the difference between profit and loss on a flock. Once the birds learn to roost, this danger no longer exists, but under ordinary brooding methods they will roost only after they have feathered—until then they will seek the heat of the brooder.

A simple method of training chicks to roost before the brooding season is over has been developed by a commercial poultryman who uses ordinary electric hovers. He has found it especially helpful in raising the heavier breeds, which do not readily take to roosting of themselves. According to his records, the cost of the extra electricity required has not been excessive. The idea appears to be one with which other small-scale growers might experiment.

Three lengths of sash chain are hooked to eyebolts fastened with nuts to the top of the electric hover, as shown in Fig. 1 and in close-up detail in Fig. 3. Each chain passes over a pulley on the ceiling and down again to a hook screwed into the wall. Insert key rings on the three chains to hold the hover level 5" above the floor (Fig. 2), and others to enable it to be suspended near the ceiling at the end of the brooding season (Fig. 3). In the chain marked *A* insert another key ring where it will hold the hover about 10" above the roosts and parallel to their slope, as shown in Fig. 1. Between this ring and the one previously attached at the end of chain *A*, insert twelve more, spacing them at equal intervals.

The brooder is left as in Fig. 2 for the first two weeks. The roosts are then set in position. As you arrive each morning to fill the feed hoppers, hook chain *A* down one key-ring link. If this is done the first thing in the morning, the birds have all day to get used to the new and higher position of the hover. By the time they are a month old, the hover should be about as shown in Fig. 1, and the chicks, following its warmth, will have learned to roost. Leave the hover in this position for the last three weeks of the brooding season.

As the slant of the hover will determine the slope of the roosts, it is well to build them to suit. However, the roosts should not slope too steeply. Be sure the lowest is within easy reach of the young chicks.

Left, the hover as it remains for the first two weeks. It is then slowly tilted by hooking chain A down one link a day, until it hangs as in Fig. 1. At right below, it is raised at end of the brooding season

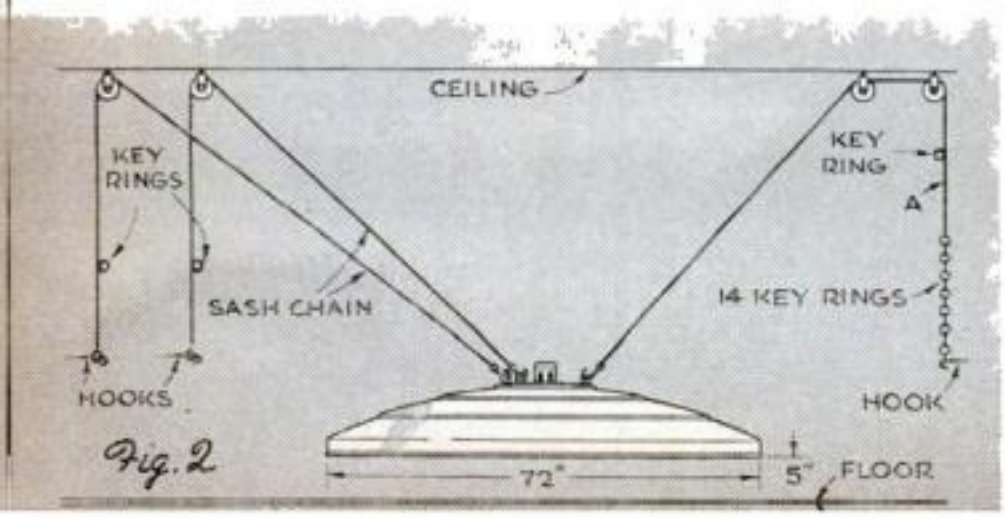


Fig. 2

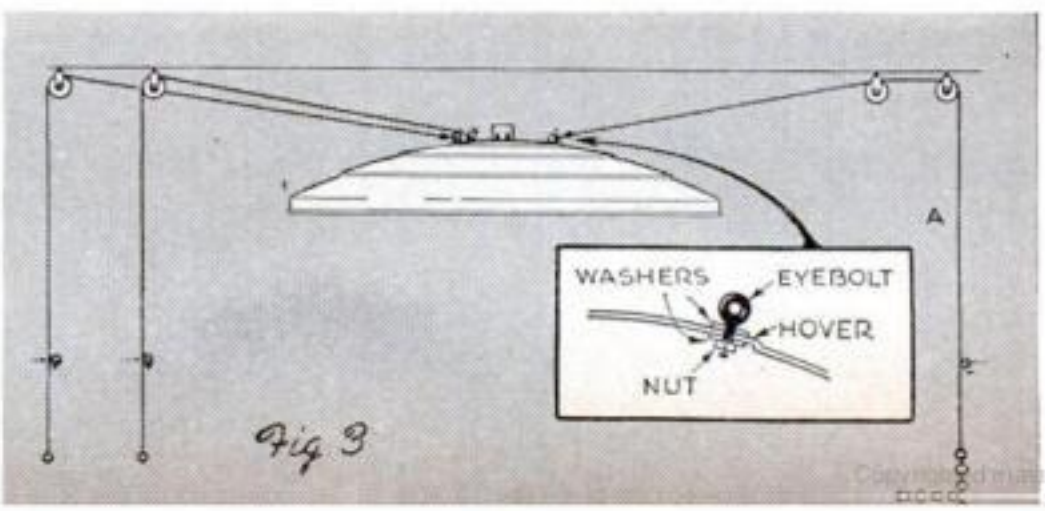
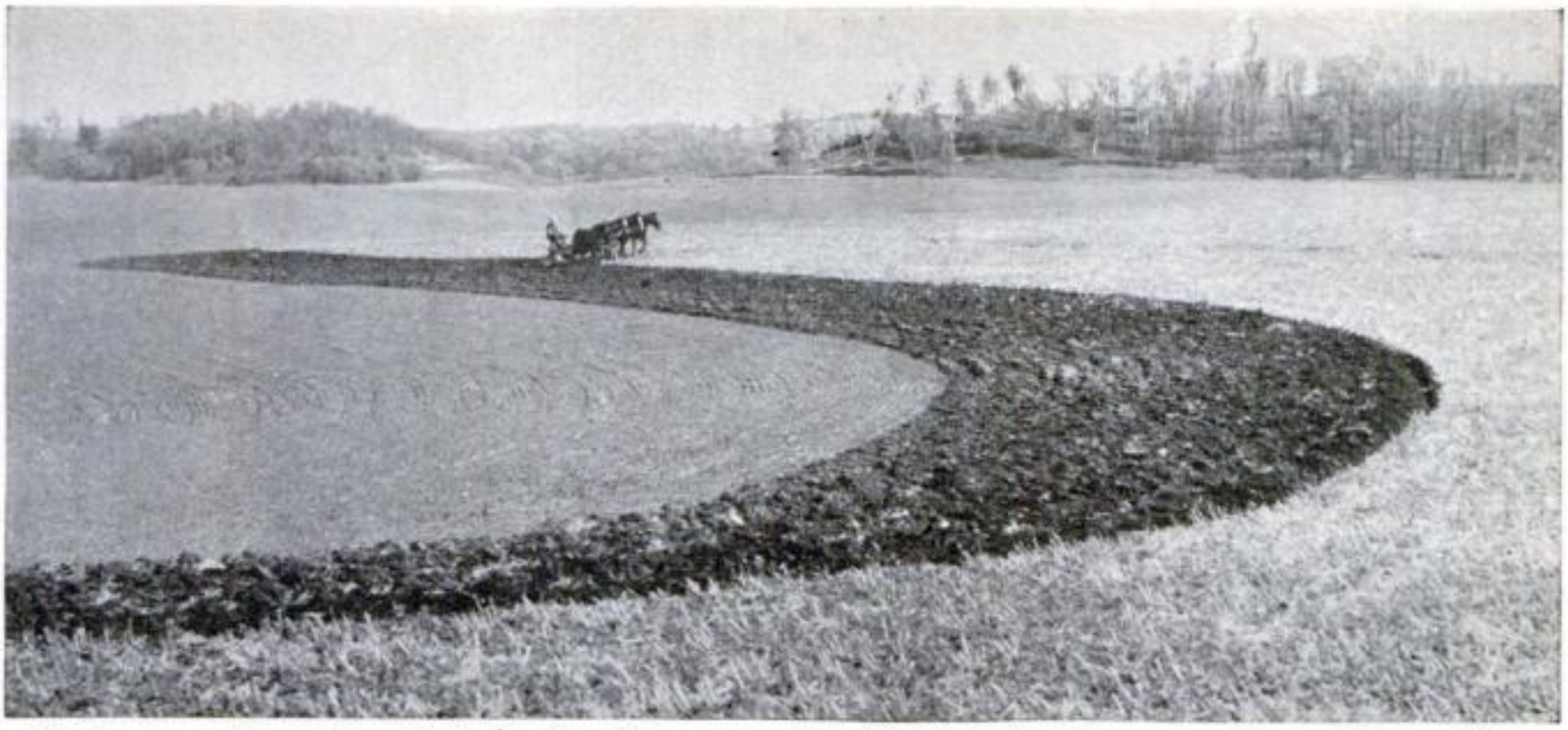
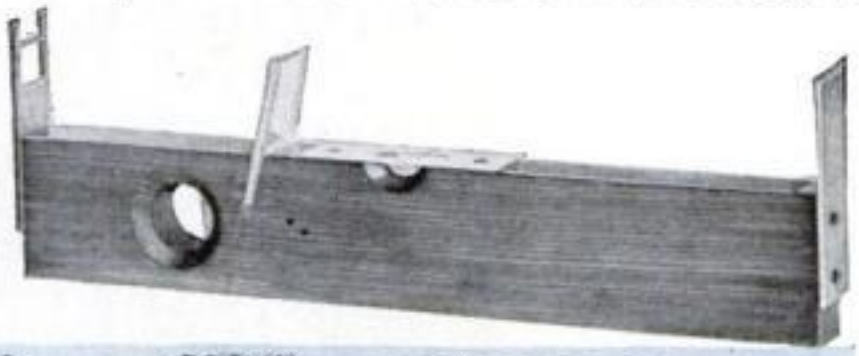
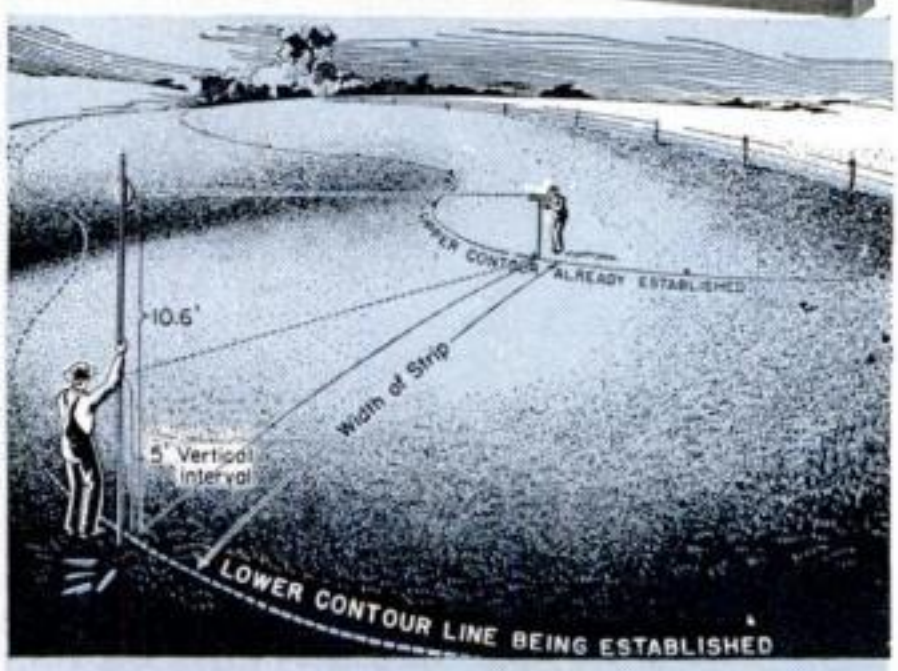


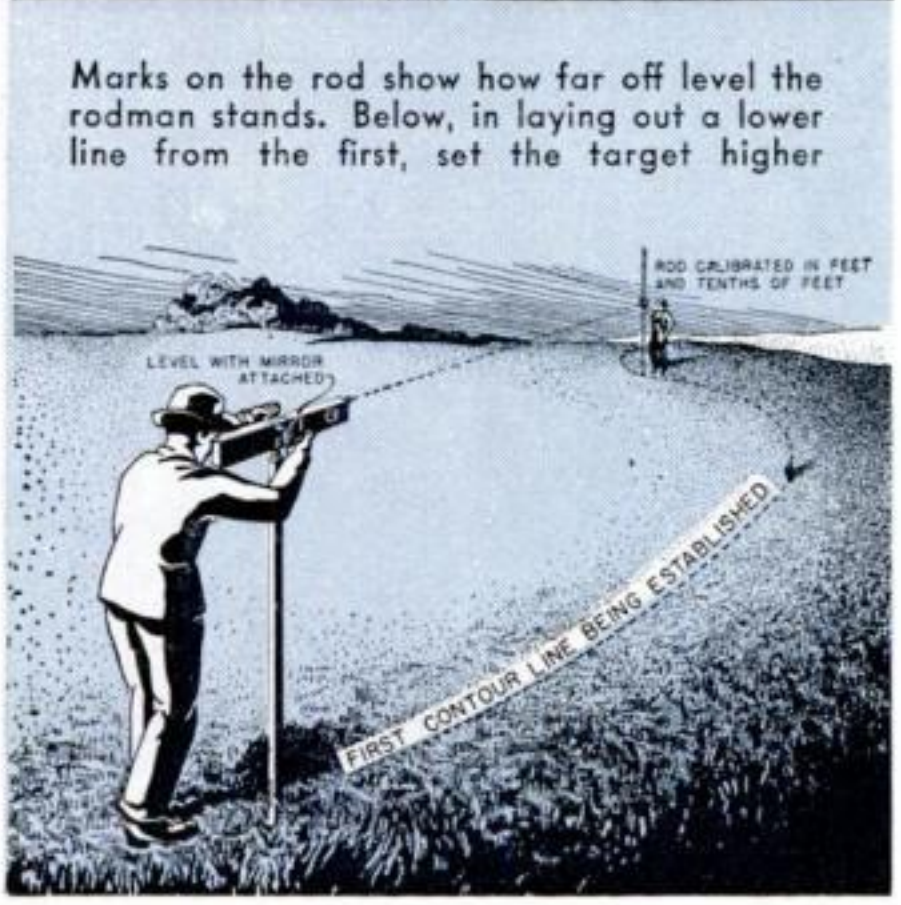
Fig 3



Plowing a contoured sweet-clover strip for corn on the Adolph Solum farm near Spring Grove, Minn.







HOMEMADE LEVEL LOCATES LINES FOR *Contour Plowing*

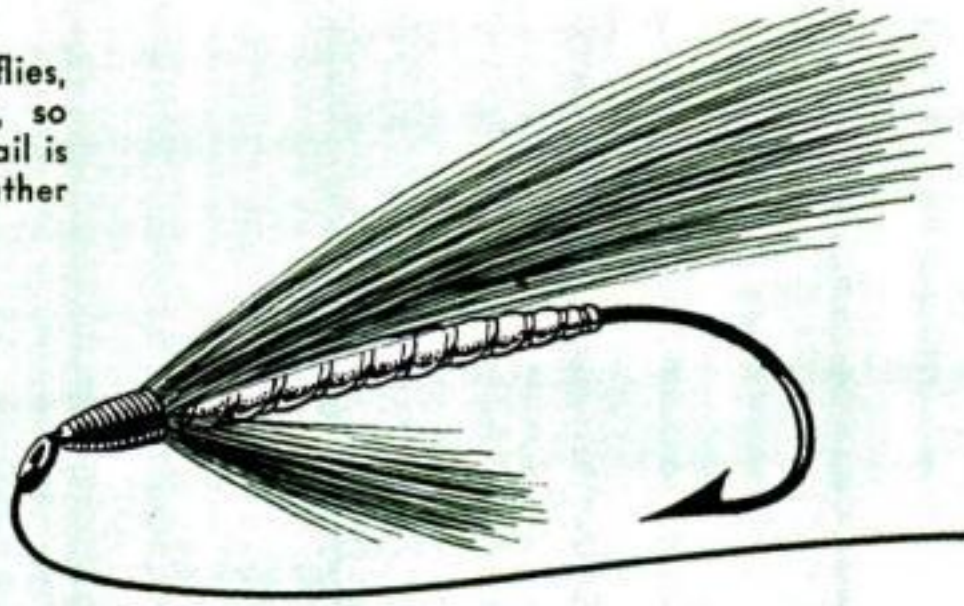
By WALTER W. JOHN
U. S. Soil Conservation Service, Milwaukee, Wis.

CONTOUR plowing is a tried, effective method of conserving topsoil and water on hilly ground. Each level furrow, running at right angles to the slope of the ground, helps halt the downward flow that results in erosion. This method of plowing also saves from 5 to 20 percent in tractor fuel.

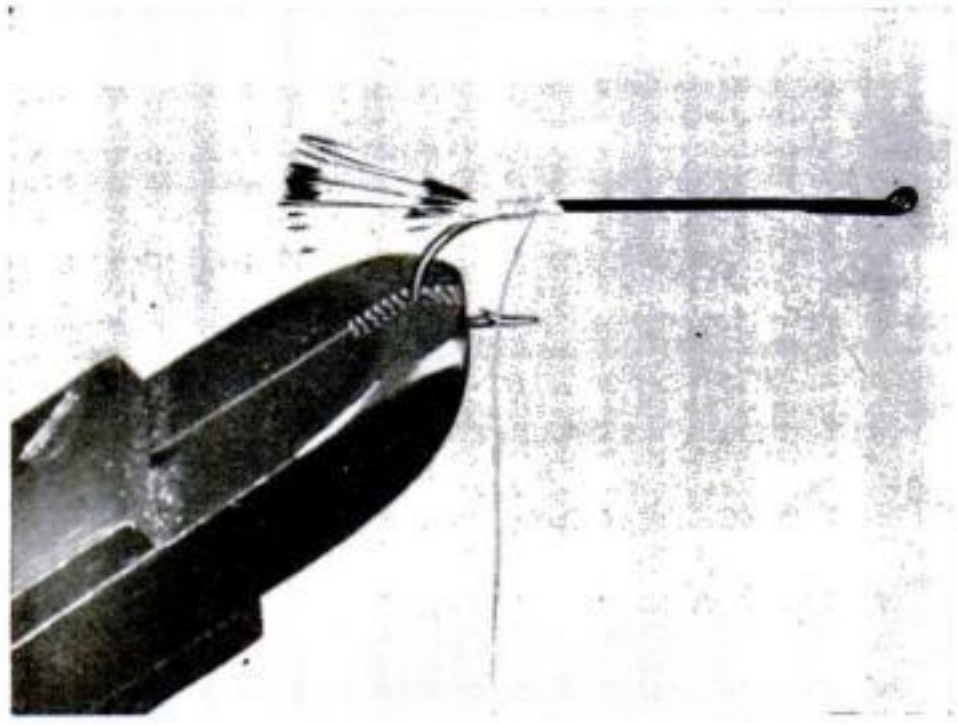
Technical experts use expensive instruments for laying out contour lines, but Ray Cox, of Red Wing, Minn., has adapted a low-priced carpenter's level for the purpose. A metal plate is screwed to each end as shown in an accompanying photograph. One plate has a peephole, the other a wire sight soldered across a cut-out section at the same height as the peephole. A mirror is glued into a slot to reflect the spirit bubble to the user as he takes a sight.

The level is mounted on a leg or tripod at a fixed height. A helper carries a rod calibrated in feet and tenths of feet or inches and having a movable target. The rodman moves this from point to point along the line, going uphill or downhill until the surveyor sights the target at the same height as that of his level, with the spirit bubble between its centering lines. Stakes are used to mark out the contour line thus established. Other lines are marked in the same way, or else from the first one by setting the target at a suitable height.

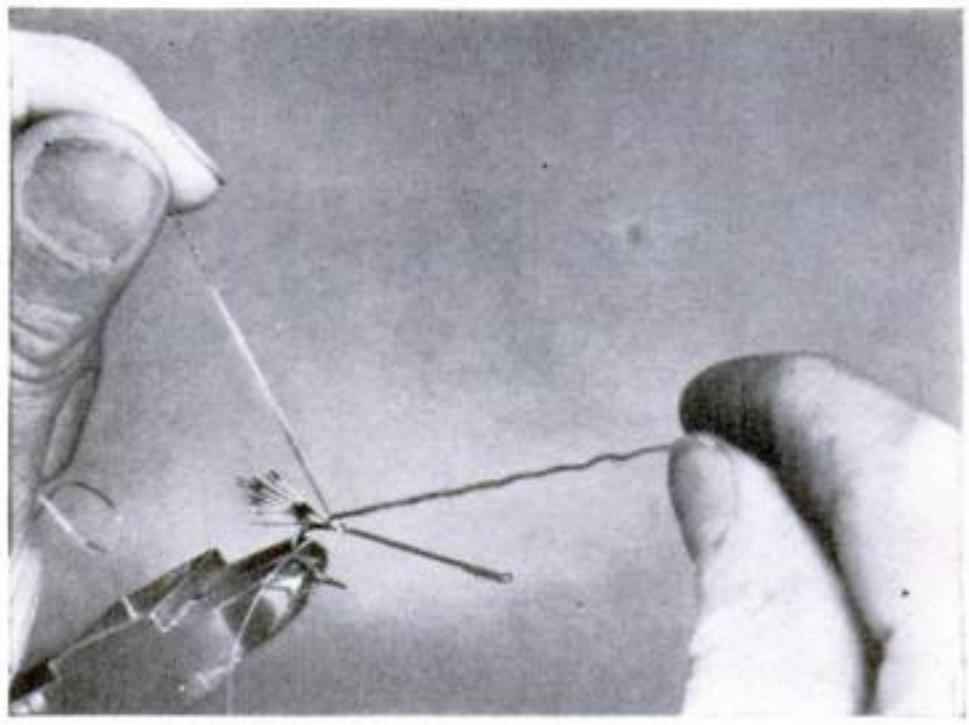
One of the popular flies, a Bucktail Streamer, so named because bucktail is used instead of a feather



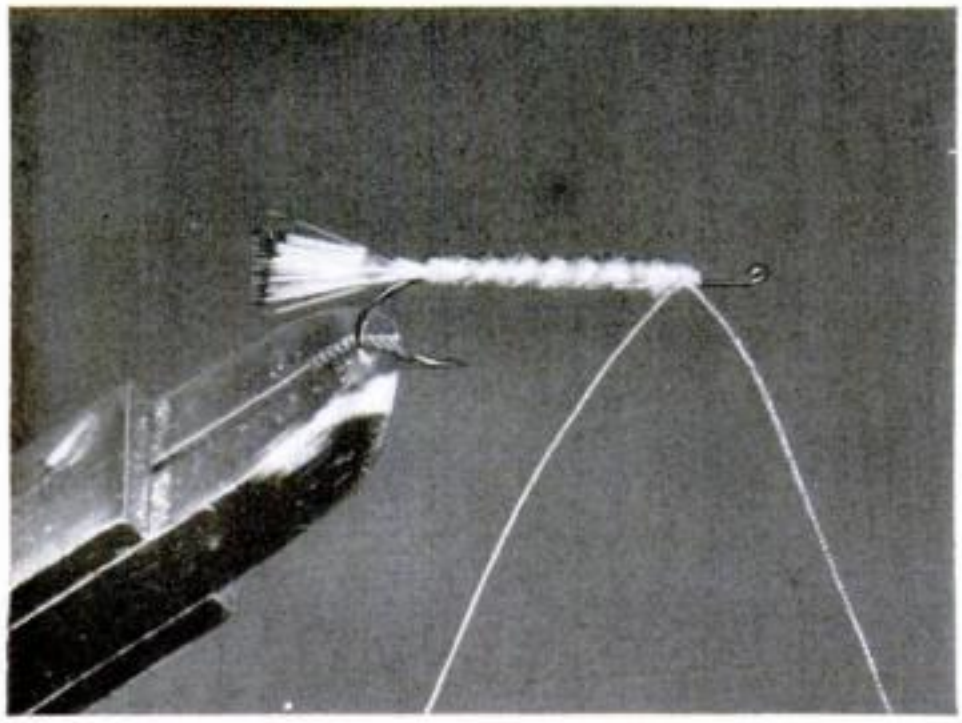
Fly Tying Made Easy



1 Binding on the tail is the first step in tying a Bucktail Streamer, but the tail can be omitted if desired. This is a light-wire salmon dry-fly hook



2 Two materials are used for the body, wool for the base and tinsel for the ribbing. They should both be tied in at the same time



3 Letting the tinsel hang, wind in the wool first, tie off, and shape. Then wind in the ribbing. Leave the space between the body and eye of the hook

4 An end of white bucktail showing quality and evenness is picked out, segregated, and cut off in length to suit the size of the hook

PART TWO

By RAY BERGMAN

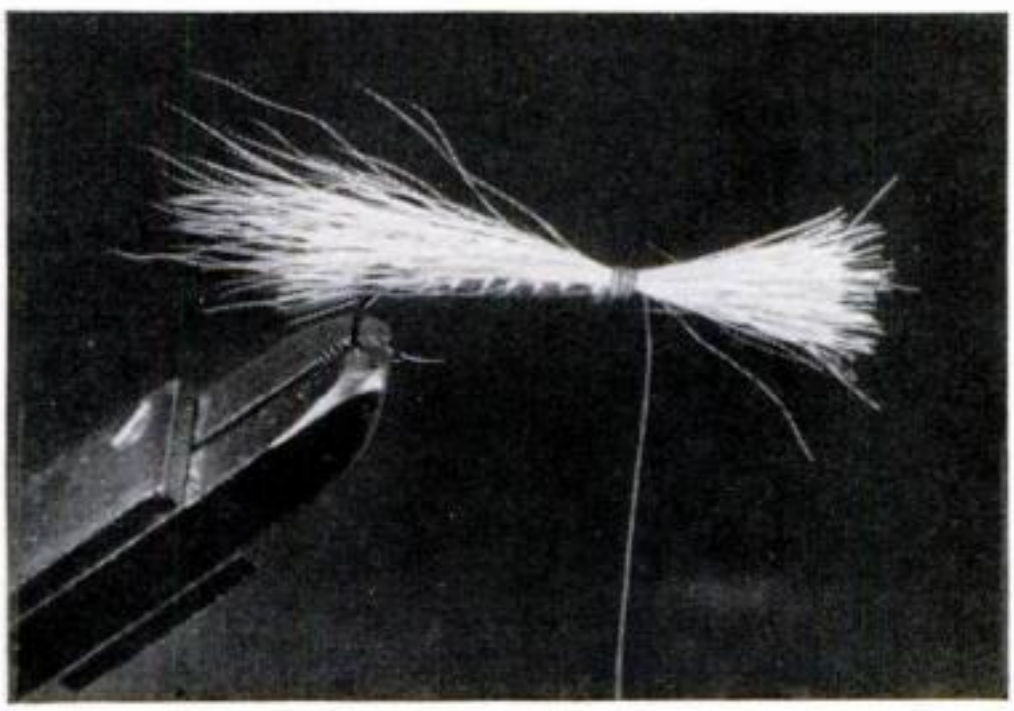
Angling Editor of "Outdoor Life"

IF YOU are now able to tie a presentable Royal Coachman and have practiced the knots and made other flies as suggested in the first installment, you are ready to learn to tie a typical bucktail. This is a fly with a bucktail streamer instead of a feather streamer.

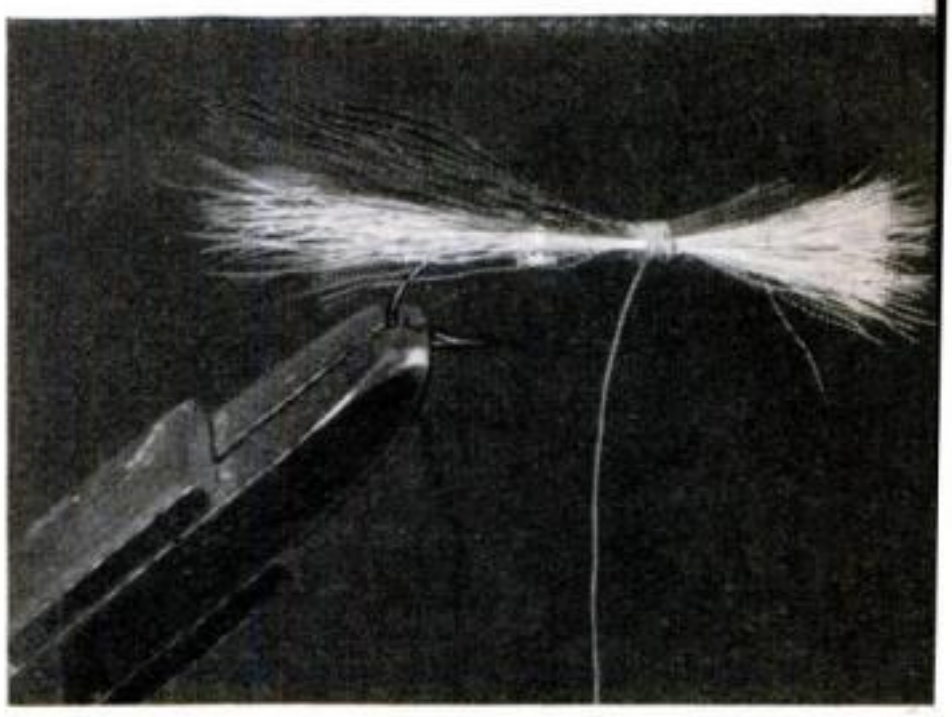
Tying a Bucktail. The first operation is putting on the tail, if one is desired, as shown in Fig. 1. The hook in the illustration is No. 3 in the group in Part I. The body of the fly is begun as in Fig. 2. We are going to use two materials for the body, wool for the base and tinsel for the ribbing. You will get best results if both are tied in at the same time. In this instance we first wind in the wool and tie off, letting the tinsel hang. After the wool is on and shaped, we come back and wind in the ribbing to get the effect shown in Fig. 3. Note the space left between the end of the completed body and the eye of the hook. This is important.

We are now ready for the wings or streamers, in this case bucktail hair. Taking a white bucktail (Fig. 4) and picking out an end which shows quality and evenness, we segregate it with our fingers and cut off the length according to the size of the hook. We lay this bucktail, which has been held firmly from the first, on the hook as in Fig. 5. We now duplicate the operation with black hair—skunk, black squirrel, or dyed bucktail. This is tied on top of the white hair as in Fig. 6.

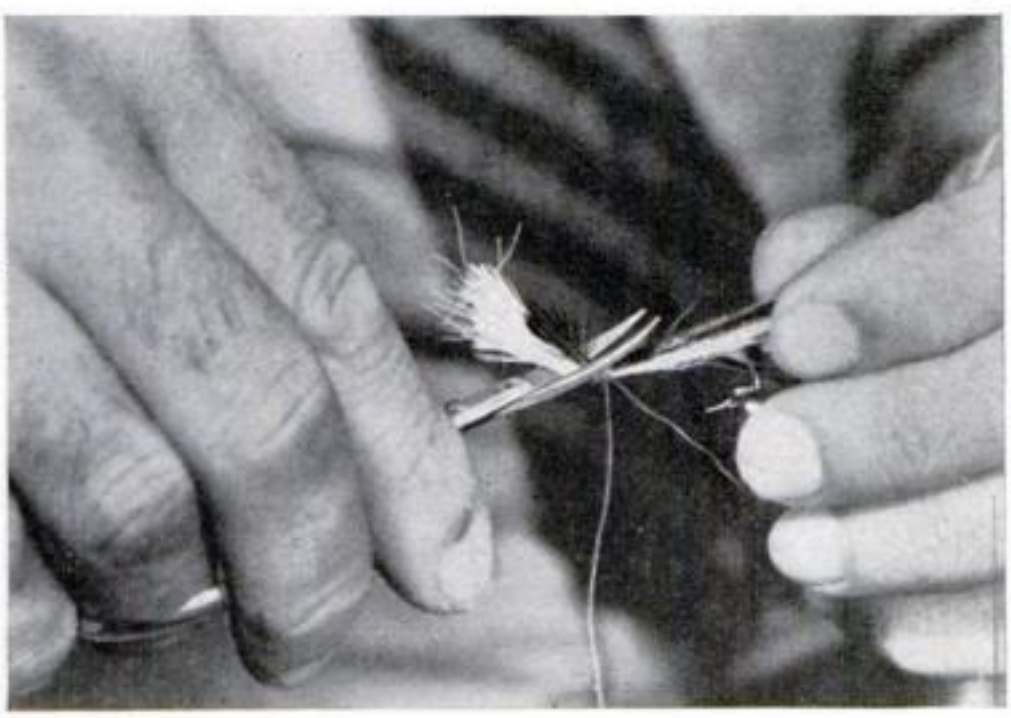
Now we cut off the end of the hair at the eye of the hook (Fig. 7) on a slant so that subsequent winding of the head will bind the ends securely and prevent the hairs



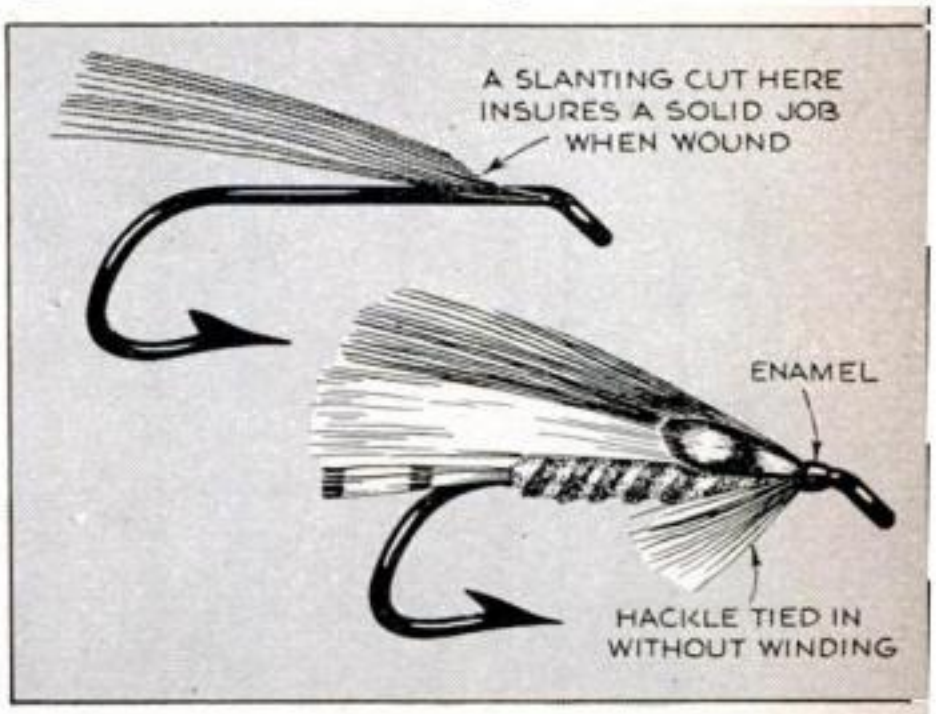
5 This white bucktail, which has been held firmly from the moment it was first selected, is next laid on the hook and tied at the end nearest the eye



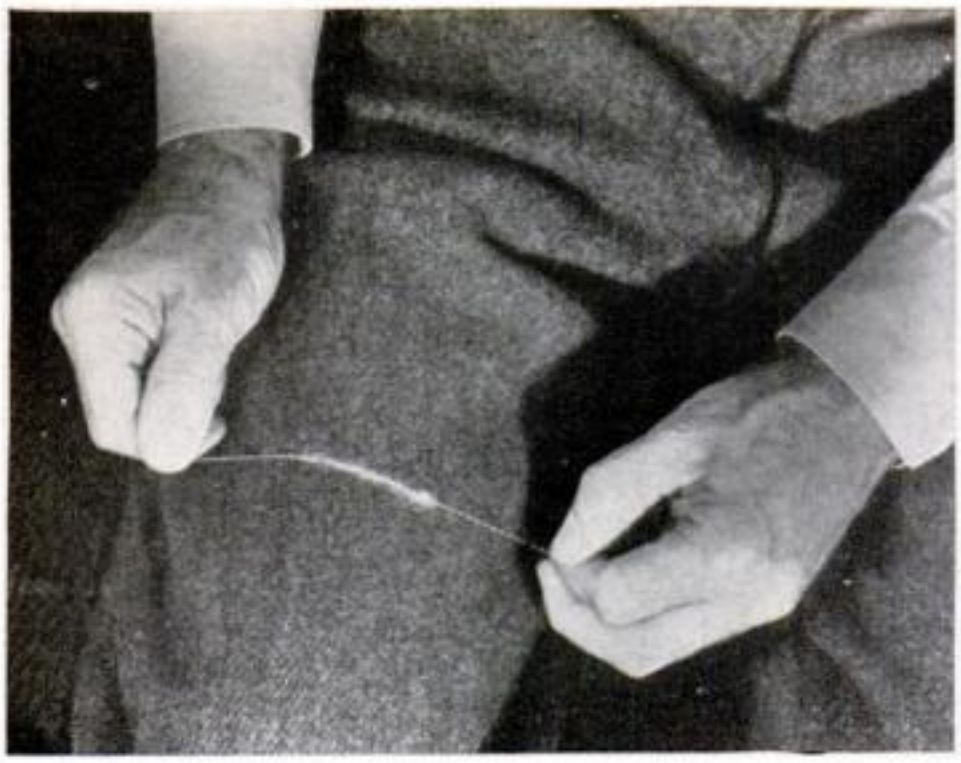
6 The operation of selecting and tying in the white bucktail is duplicated with black to give two colors. Skunk or squirrel can be used



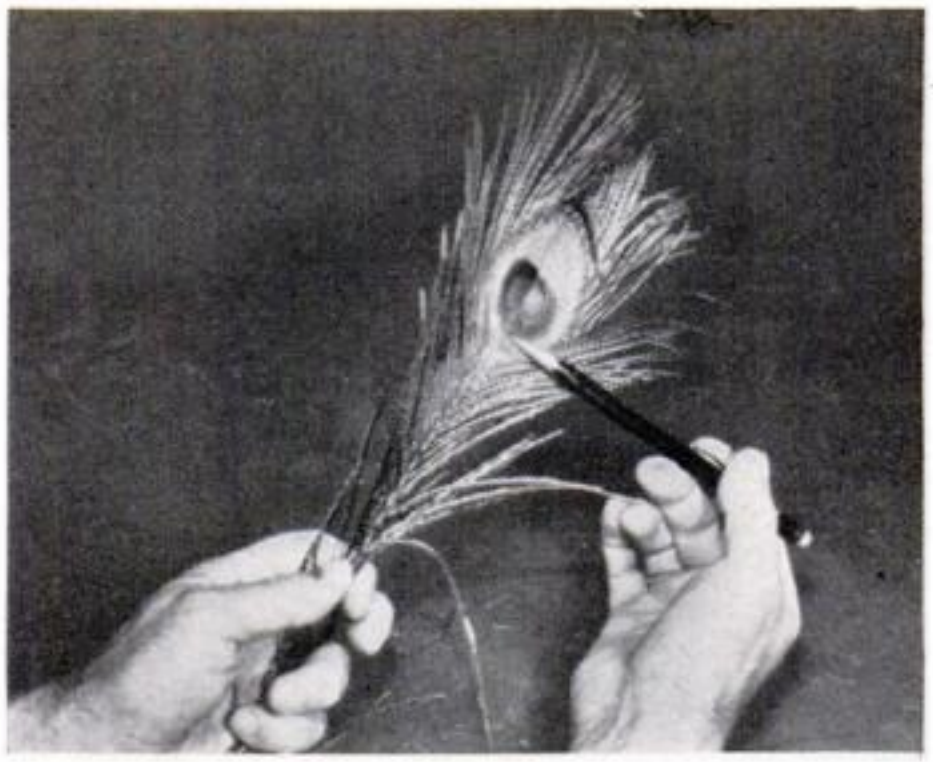
7 The end of the hair at the eye is now cut off. This is done on a slant so that later winding of the head will prevent the hair from being pulled out



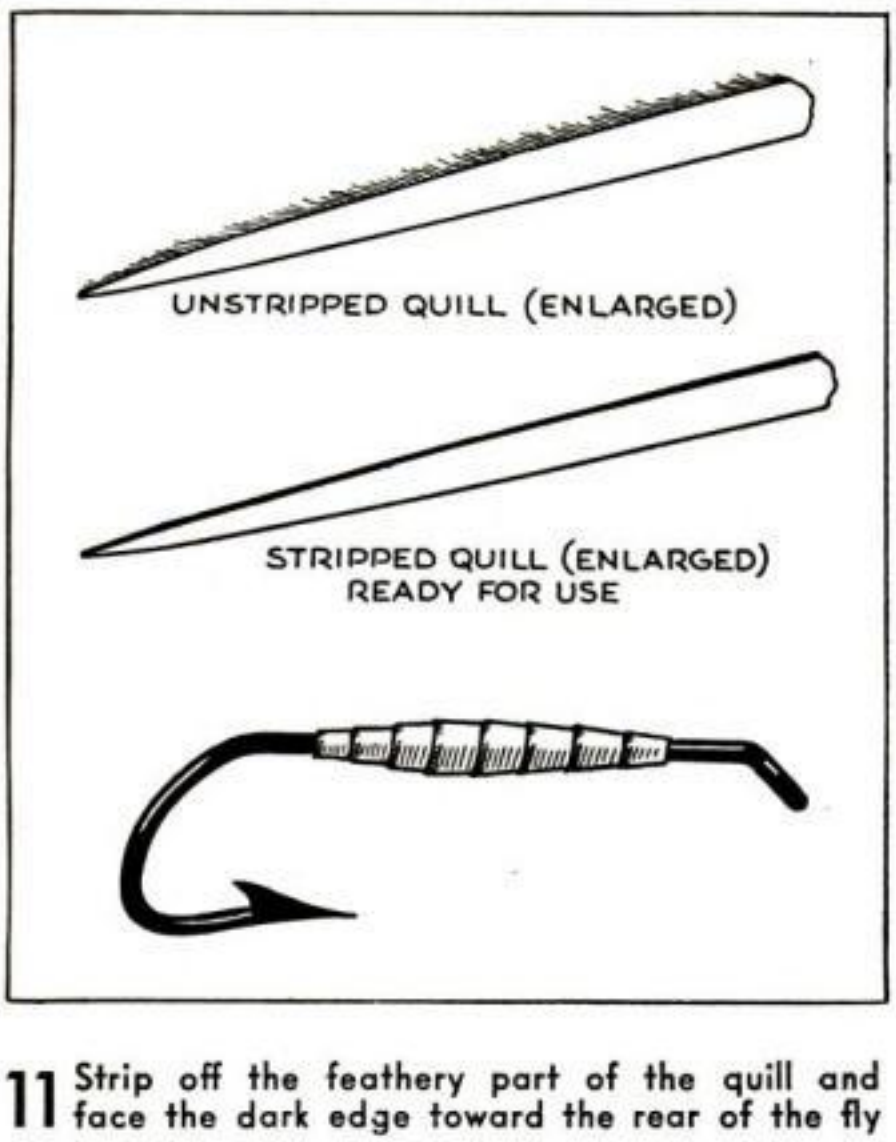
8 A drop of lacquer or cement before starting to wind the head will make it secure. The hackle is next tied in as in the lower drawing



9 Fur makes a good body; it gets juicy looking and is buoyant. Before use, it is spread out loosely and spun on a waxed thread, which is rolled over it



10 Quills also make excellent bodies, those most commonly used coming from a peacock eye. Build the hook up first with silk thread



11 Strip off the feathery part of the quill and face the dark edge toward the rear of the fly

from pulling out (top, Fig. 8). A drop of lacquer or cement on the part before the winding is started will help.

The hackle goes on next. While this may be wound in like dry-fly hackles, by far the best way is to tie it in as in the lower drawing in Fig. 8, which shows the complete fly. An important item in finishing streamer heads is to use enamel. It builds up a minnow headlike shape and is very attractive.

Materials for Bodies. It is surprising what creations you can invent. Almost anything that can be wound on a hook is usable. The regular items are wool, tinsel, raffia grass, silk, herls from different feathers, and fur.

Material such as fur must be spun on a thread. Pluck out a tiny bit of soft underfur, spread it loosely on the trousers, and spin it on waxed thread by rolling the thread over it as in Fig. 9. The result is a wool body with tapered ends.

Quills such as those from peacock eyes (Fig. 10) make good bodies for wet or dry flies, but not for streamers. The feathery portion is stripped off (Fig. 11) with the nails of the thumb and forefinger. When winding on, start at the back end of the hook and face the dark edge of the quill toward the rear of the fly. The result should be as shown at the bottom of Fig. 11.

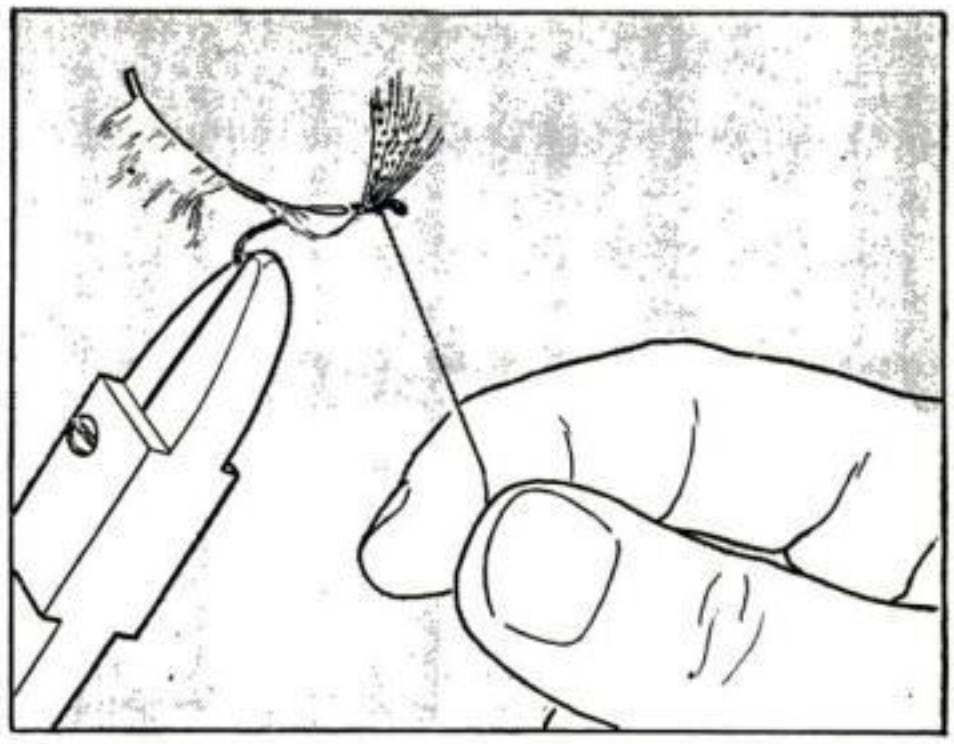
In making either quill or tinsel bodies, or when using any flat material, the hook shank should first be built up to shape smoothly with silk winding thread, floss, or the like. Quill or tinsel alone will not make a good job.

Wing Suggestions. White feathers from the outside of a mandarin duck skin make excellent wings for Fan-Wing Royal Coachman flies. The speckled ones bordering the white are used for Cahills. Feathers somewhat similar but cheaper may be obtained from the teal and mallard. These are often dyed.

Hackle feathers (Fig. 12) are particularly adapted to the tying of spent-wing flies as in Fig. 14, but are also good upright wings, lasting better than the quill-wing varieties. These hackle-point wings are better if put on separately when used to make a spent fly. For upright-winged flies they are tied in pairs. Of course, when using the point wing, all the feather is stripped off except the point.

Figure 12 also shows what should be done with a hackle feather intended for a dry

12 Hackles should be stiff and numerous for a dry fly to float high. At left they have been spread for use. At right, the feather before stroking

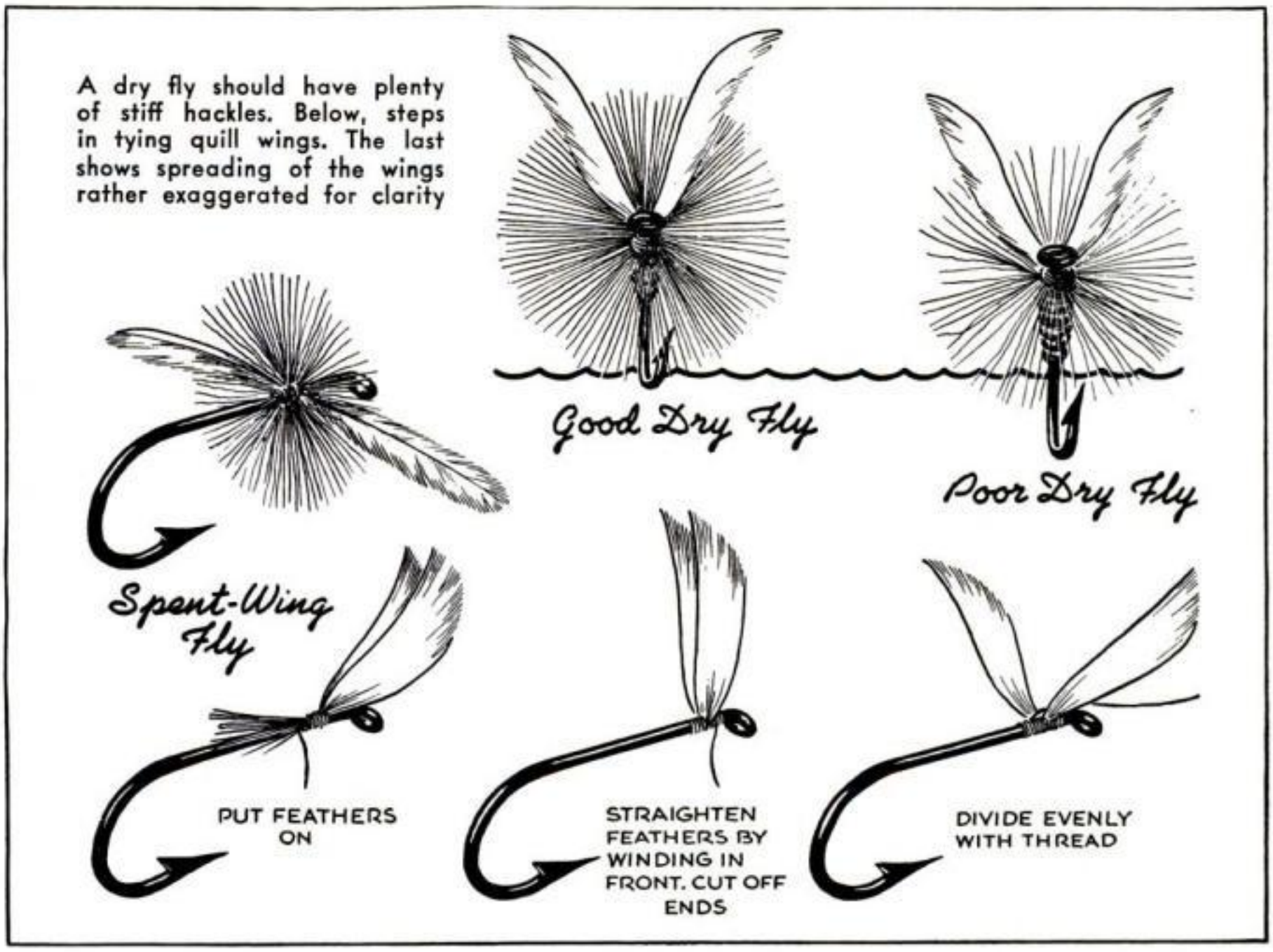


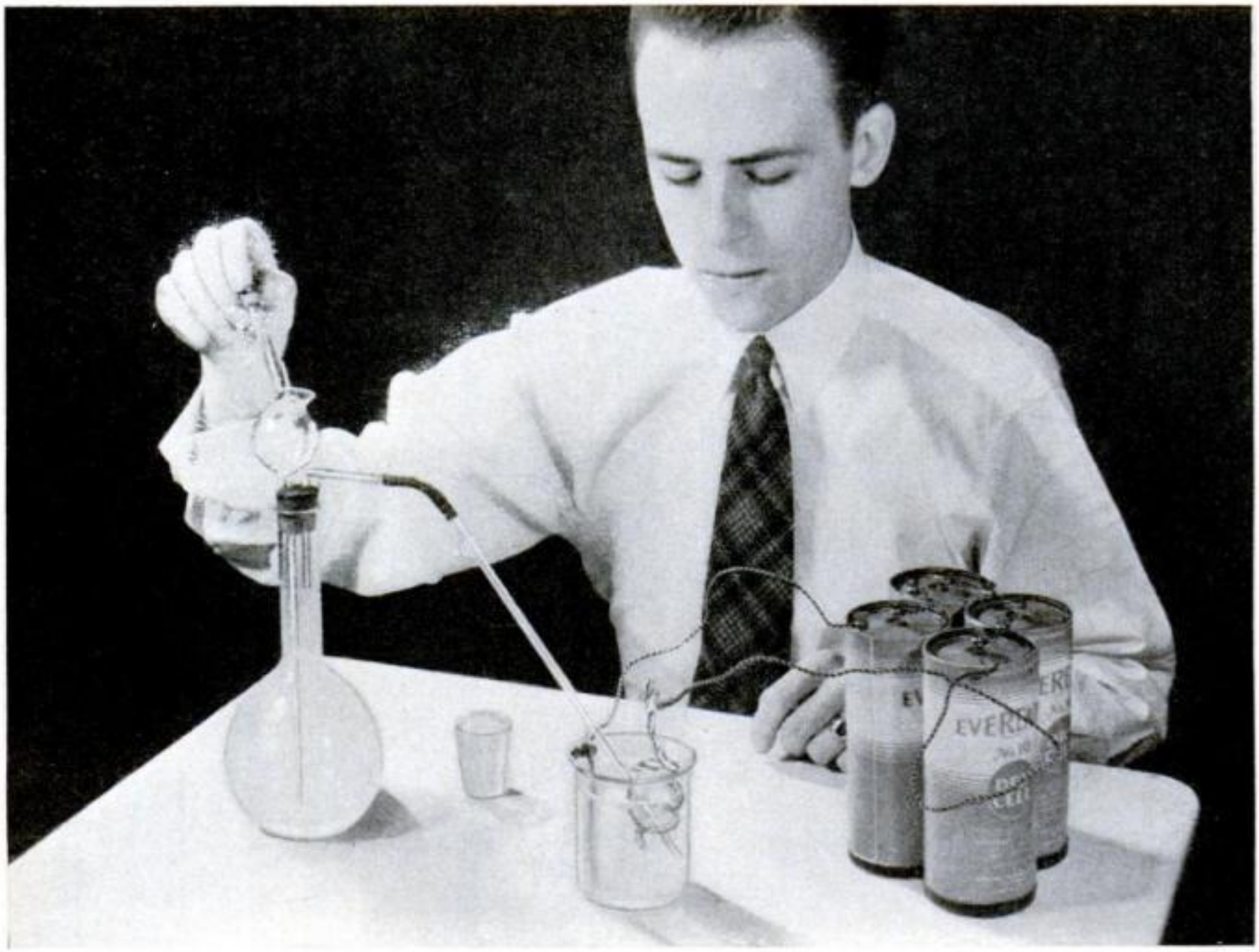
13 Tying mandarin wings. Here the thread is being wound against the feather from in front to make it stand up. The feather is then divided and tied

fly. On the right is a feather just as it came from the neck. The one at the left shows the hackles spread for use. This is done by stroking softly toward the butt with the thumb and forefinger so that the fibers stand out and point toward the tip. Soft fibers straighten out completely or, worse yet, point toward the butt, and are suitable only for wet flies. If only a few soft hackles are used, the fly will float poorly (upper right, Fig. 14).

Figure 13 shows an easy way to tie mandarin wings. About half a feather from the flank is tied on and then evenly divided. Although a bit wasteful of material, it makes as good a job as separately cut wings.

14 Left to right, a spent-wing fly, a good dry fly, and a poor one. Bottom, three steps in tying wings





Commercial production of white lead can be duplicated in the home laboratory by passing current through a spiral of lead foil suspended in an electrolyte and bubbling carbon dioxide over the spiral

Easy Experiments Show How Industry Combines

ELECTRICITY *AND* CHEMISTRY

Pure Copper and White Lead Can Be Produced, Batteries Made, and Polarity Tested in Your Home Laboratory

TO REFILL A DEAD DRY CELL, break the sealing wax on top, dig out the contents, clean the inside of the zinc, and line with blotting paper. Stand the carbon rod in the center and refill with a mixture of ten parts manganese dioxide, ten parts powdered carbon or graphite, two parts sal ammoniac, and one part zinc chloride, all moistened with enough water to make a paste. Then seal the cell again with sealing wax.

MARVELOUS as chemistry appears as a distinct science, combined with electricity it opens even more vast fields to experimentation and industrial application.

Recently it was shown here how industry utilizes electrochemical magic to obtain chlorine and sodium hydroxide from common salt. Now we shall learn to duplicate on a small scale the process by which most of the world's pure copper is produced, how the manufacture of white lead pigment has been shortened from months to a few hours, the workings of storage and dry-cell batteries, and, for good measure, how to conjure up a solution that indicates electrical polarity.

Curiously enough, copper refined electrochemically makes possible the present great electrical industry itself. Next to silver, it is the best conductor of electricity known, yet even slight traces of other elements cut its conductivity tremendously. By passing an electric current through a bar of impure copper to a thin sheet of pure copper in a vat containing a solution of copper sulphate, pure copper is deposited on the plate as the bar dissolves, the impurities settling on the bottom or going into permanent solution.

In our home demonstration of electro-refining, we can go even further and produce pure copper by separating it from zinc in the alloy brass, as shown in an accompanying photo, using for our vat a small beaker containing about ½ oz. of copper sulphate dissolved in 4 oz. of water. A clean brass screw is fastened to a wire connected to the positive terminal of a dry cell. The end of another wire, running to the negative terminal, is scraped free of insulation for several inches and bent into a grid. Immerse this brass anode and copper cathode in the solution, and electro-deposition starts immediately.

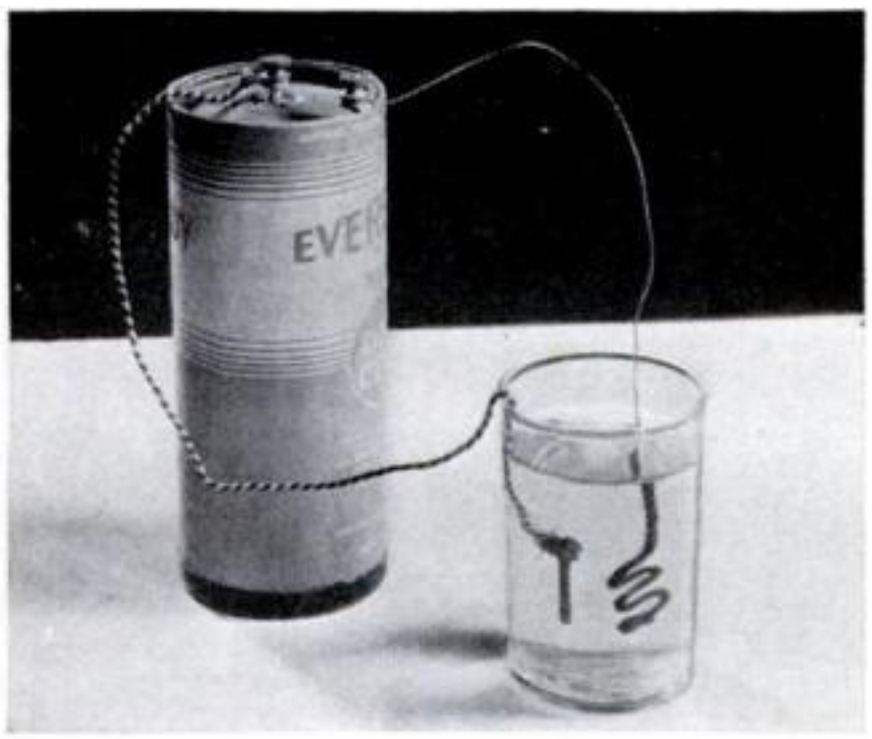
Until the electrolytic process of making white lead was invented, this important paint ingredient was made by the slow method of partly covering lead plates with dilute acetic acid and burying the combination under heaps of spent tanbark. During several months of treatment, the lead went through a transformation beginning with lead acetate, produced by the acid, and winding up with white lead, or lead carbonate, brought about by the reaction of the carbon dioxide that is liberated by the decaying tanbark.

Electrochemistry compresses the months into hours. We can demonstrate the method with the simplest equipment. In about 8 oz. of warm water, dissolve 75 grains of sodium carbonate and 25 grains of potassium chlorate. A strip of lead forms the cathode and a spiral of twisted lead foil the anode. Carbon dioxide is bubbled from the bottom from a tube connected with a generator made as shown in the photograph.

Connect the negative terminal of a bat-

COPPER IS SEPARATED FROM ZINC in a brass screw by action of an electric current in a solution of copper sulphate. Copper ions from the solution are deposited on a copper cathode, where they are neutralized and converted into particles of pure copper, and copper from the brass anode replaces them in the solution. The zinc falls to the bottom. If the process continues long enough, the brass screw will waste away completely.

WITH TWO STRIPS OF SHEET LEAD, separated by a bent glass tube, and about one part concentrated sulphuric acid in ten parts water, you can make a storage cell. Put the dilute acid in a beaker and arrange the plates as shown below. To charge the cell, connect the plates for about ten minutes to two or three dry cells in series. Remove the dry cells and connect the plates to light a flashlight bulb as shown below, to demonstrate its power.



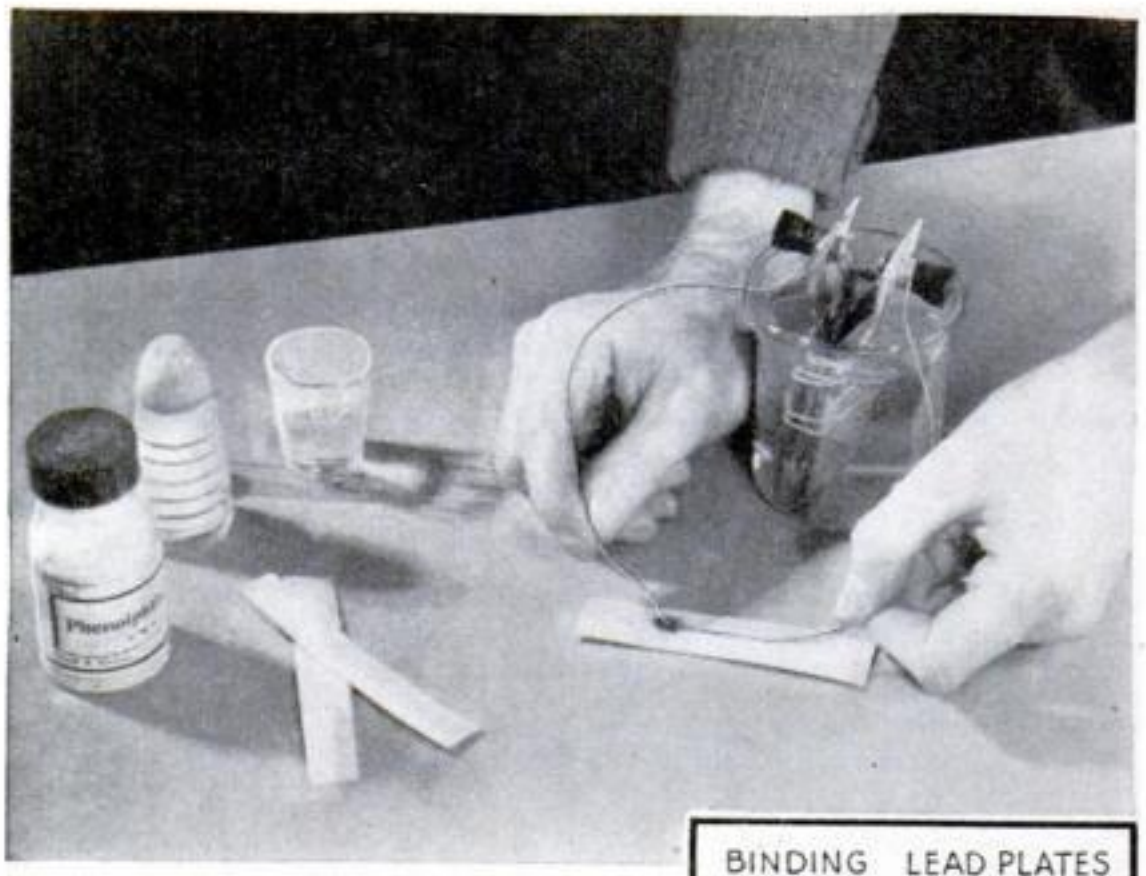
tery of four dry cells in series to the lead plate, and the positive terminal to the spiral. Immediately the lead of the spiral will begin to dissolve. If carbon dioxide is now started bubbling up through it, the dissolved lead will be precipitated by the gas as a white powder—lead carbonate.

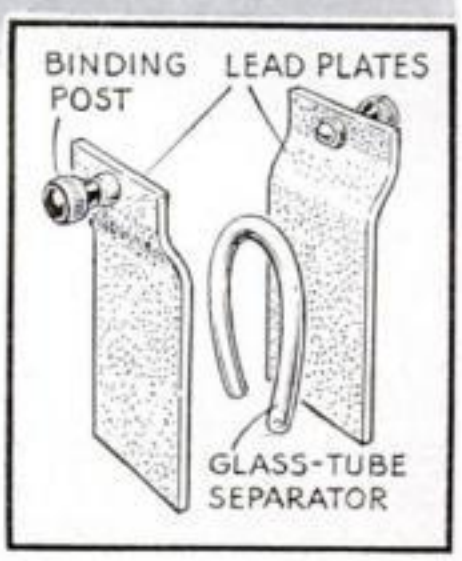
Pass an electric current through an electrolyte, or solution that conducts electricity, and you produce a chemical change. Conversely, dip two conductors into an electrolyte—one of which is acted upon more strongly by it than the other—and you produce an electric current. The storage battery utilizes both of these effects.

Dry cells are cells which cannot be recharged by applying an electric current. The chemicals themselves must be renewed. They are "dry" only to the extent that their electrolyte is absorbed in a pasty chemical mixture that keeps it from spilling. By mixing together the proper chemicals as illustrated you can refill a flashlight cell, and thus learn the mysteries of the dry cell by experience. Your refilled cell should perform almost like new.

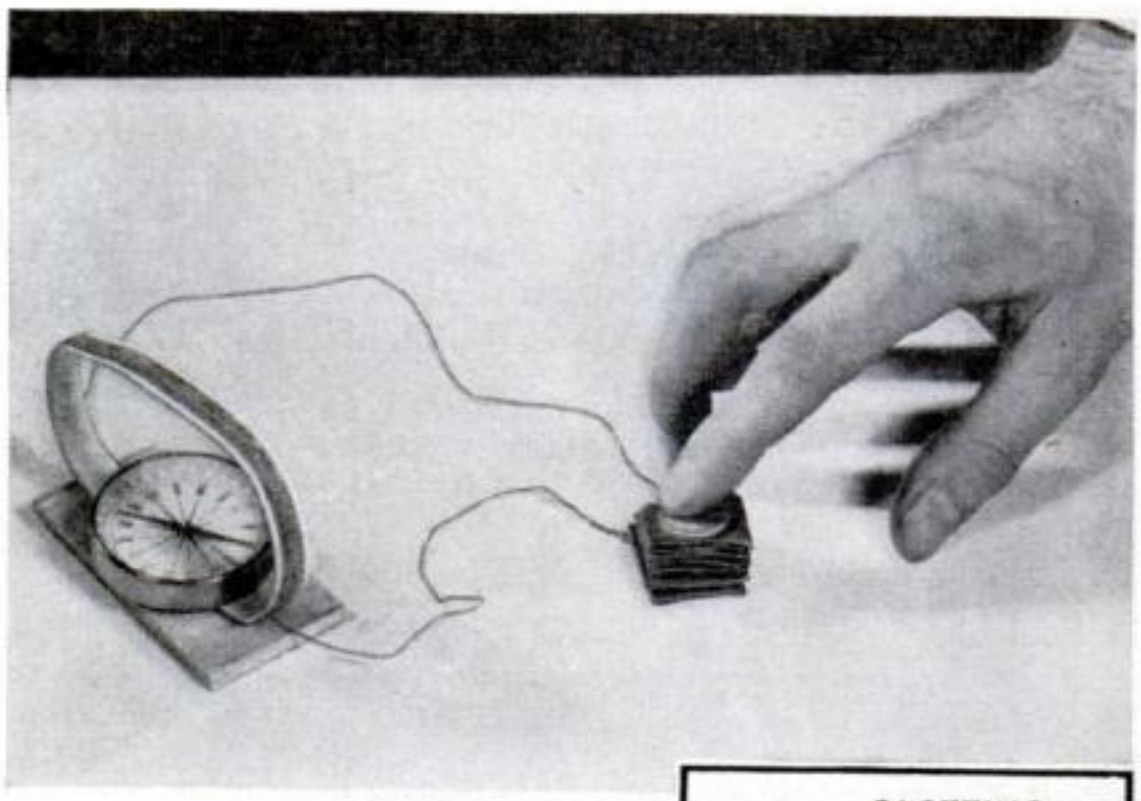
For a stunt, you can make a battery that will show a reading on a sensitive voltmeter or a home-made galvanometer, using only a half dozen pennies, as many dimes, and some bits of blotting paper moistened in salt water, following the directions given on this page.

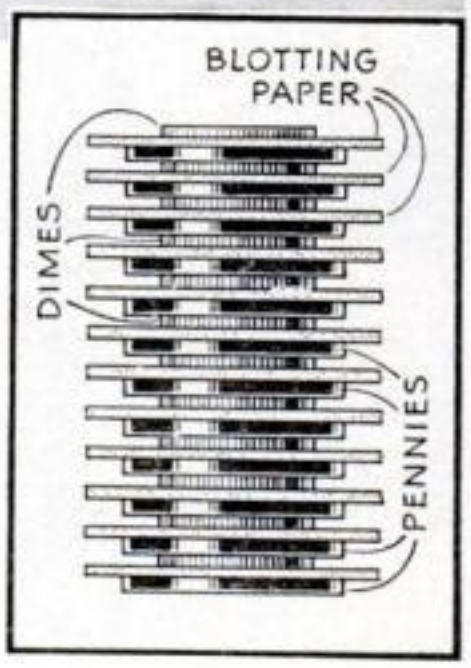
The polarity of batteries and other sources of direct current may be easily tested by means of a solution of phenolphthalein and common salt in water. Dip the two ends of the current source to be tested into a little of this solution, and the solution around the negative wire will quickly turn pink. The salt solution is decomposed by the current into chlorine at the positive pole and sodium hydroxide, a strong alkali, at the negative.





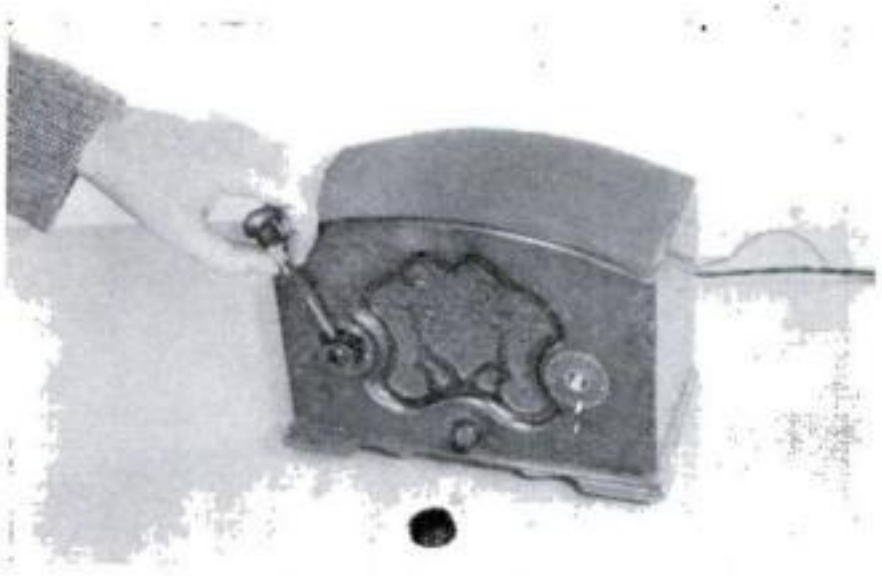
TO SHOW POLARITY of direct current, test strips may be made by moistening blotting paper with a solution of common salt and phenolphthalein in water. The current changes salt to sodium hydroxide at the negative pole, and that alkali turns phenolphthalein pink. At right, storage-cell plates.



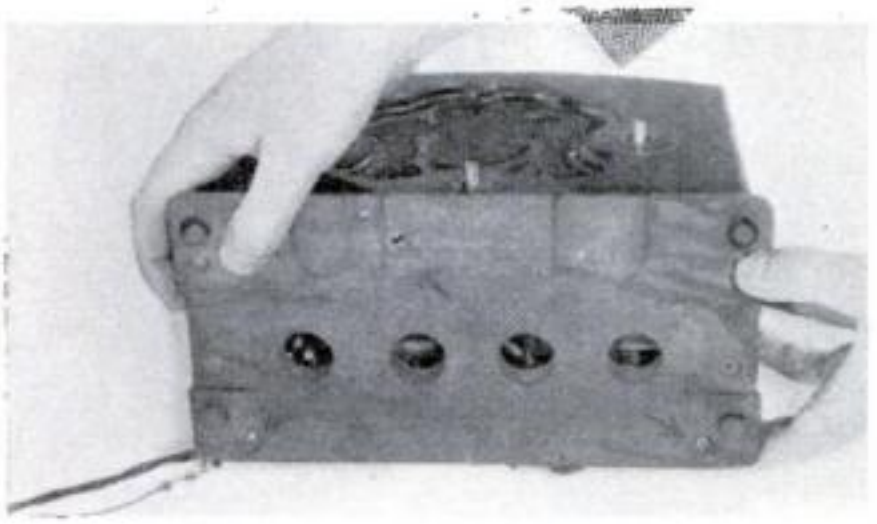


DIMES AND PENNIES, piled as shown in the diagram with the pairs separated by squares of blotting paper moistened with salt water, will make a stunt battery. As the copper is acted upon by the salt water more strongly than the silver, current is produced. Alessandro Volta made the first battery in about 1799 by using a similar pile of copper and zinc disks. The word "volt" honors him.

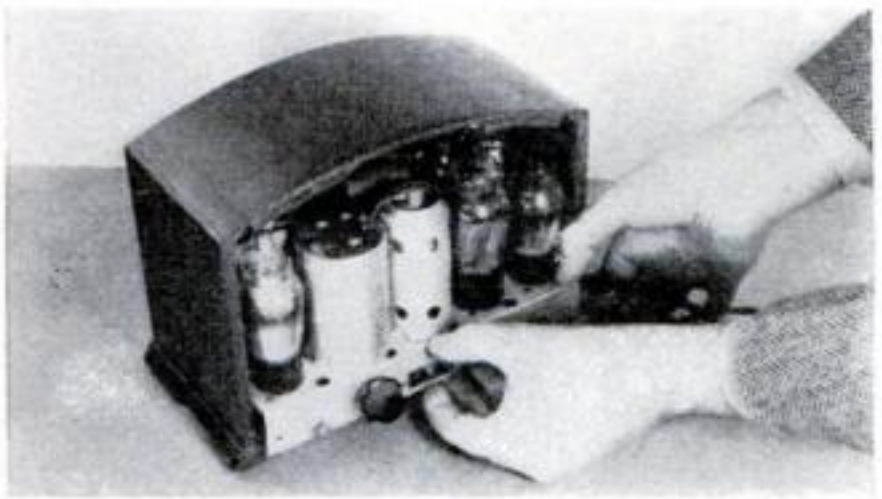
Servicing Your Radio—PART I



1 To remove the chassis, take off the knobs on the front panel by loosening the setscrews



2 Arrows point to three 8-32 machine screws on the bottom of the cabinet. Remove them next



3 The chassis can then be pulled out from the back. Dust it off well with a dry paintbrush

4 Tubes can now be removed easily for testing. Be sure to have a diagram for replacing them

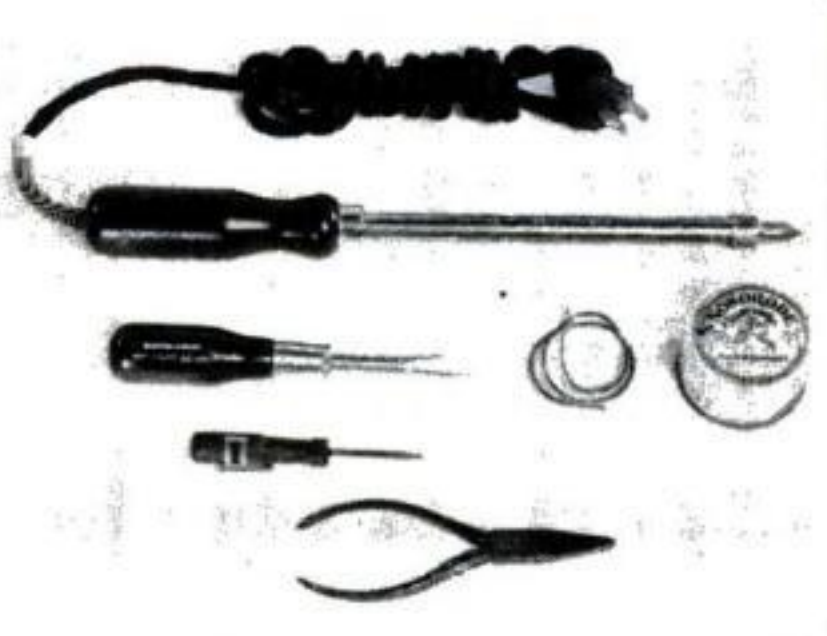
FEW TOOLS NEEDED TO PUT NEW LIFE IN THE OLD SET

WITH priorities making the purchase of new receivers more costly, and the Army and war work taking their quota of radio service men, many of us will turn to repairing our own radios. This is the first of a series of articles to appear in POPULAR SCIENCE MONTHLY in an effort to make it easier for the amateur to do his own work.

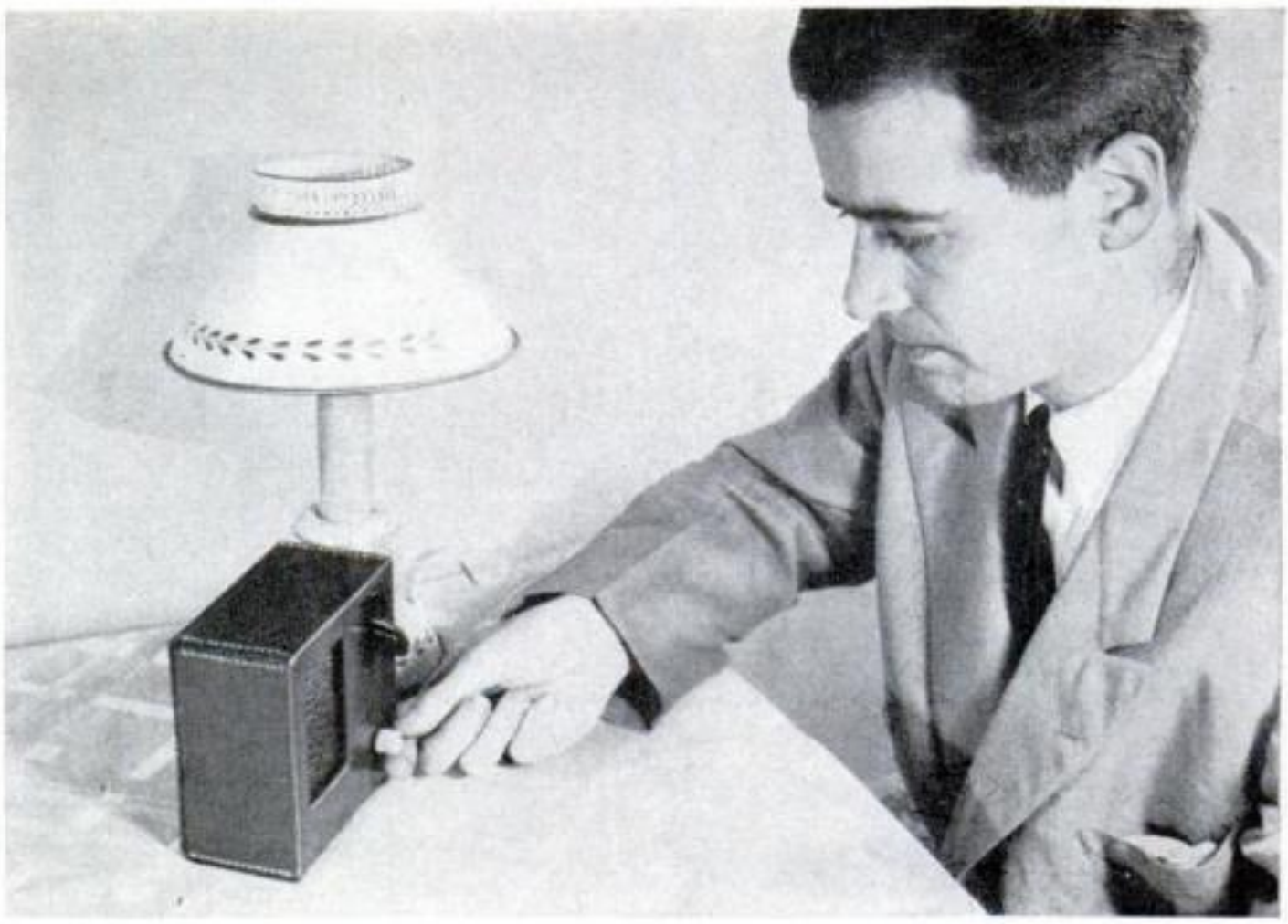
Few tools are needed for ordinary repairs. The most useful will be a 75-watt soldering iron, solder, a small can of flux paste, a pair of medium-size pliers, and two screwdrivers, the larger of the two shown below having a beveled edge for scraping insulation off wires.

TESTING THE TUBES is the first job if the receiver is not giving the desired performance. Take them to a reliable service man or radio store where they will be tested free. Some will register weak and can still be used, but replace any that are shorted or definitely bad.

To reach the tubes easily, take the chassis out of the cabinet as illustrated. Remove the knobs first by loosening the setscrews holding them or by simply pulling if they are attached by spring clips. Unscrew from the underside of the cabinet the three screws shown in Fig. 2 and pull out the chassis. Clean off dust with a dry paintbrush. Before removing the tubes, be sure each type is marked on its socket (6D6, 6A7, 75, 43, etc.) or draw a diagram to facilitate replacing.



Tools most often needed: Soldering iron, solder, flux paste, two sizes of screwdrivers, and pliers



Measuring just over 5″ square and less than 3″ thick, this receiver and its 2″ speaker cone equal the performance of much larger sets. The tiny cabinet is made of wood bound in genuine cowhide

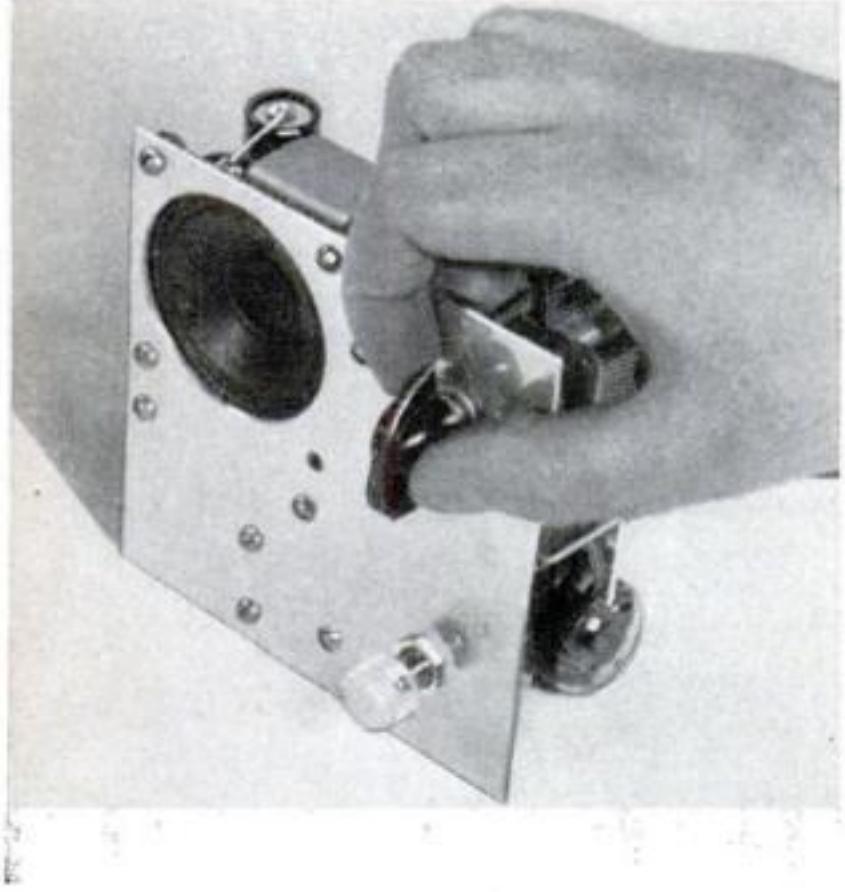
Midget AC-DC Receiver

PULLS IN LOCAL STATIONS AT FULL STRENGTH

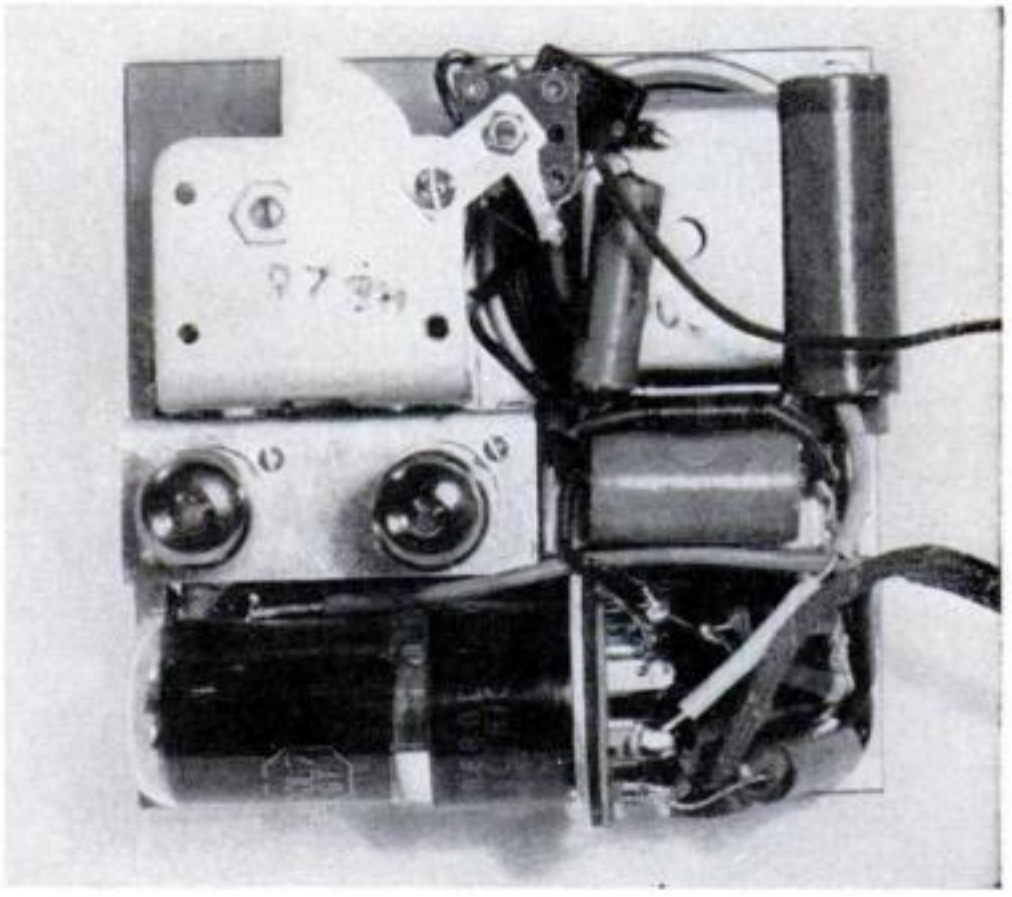
By ARTHUR C. MILLER

ALTHOUGH small enough to slip easily into a woman's handbag, this midget three-tube radio receiver is nevertheless capable of tuning in all local stations within a 50-mile radius at full loudspeaker strength on its tiny 2″ speaker, which handles up to ½-watt power without distortion.

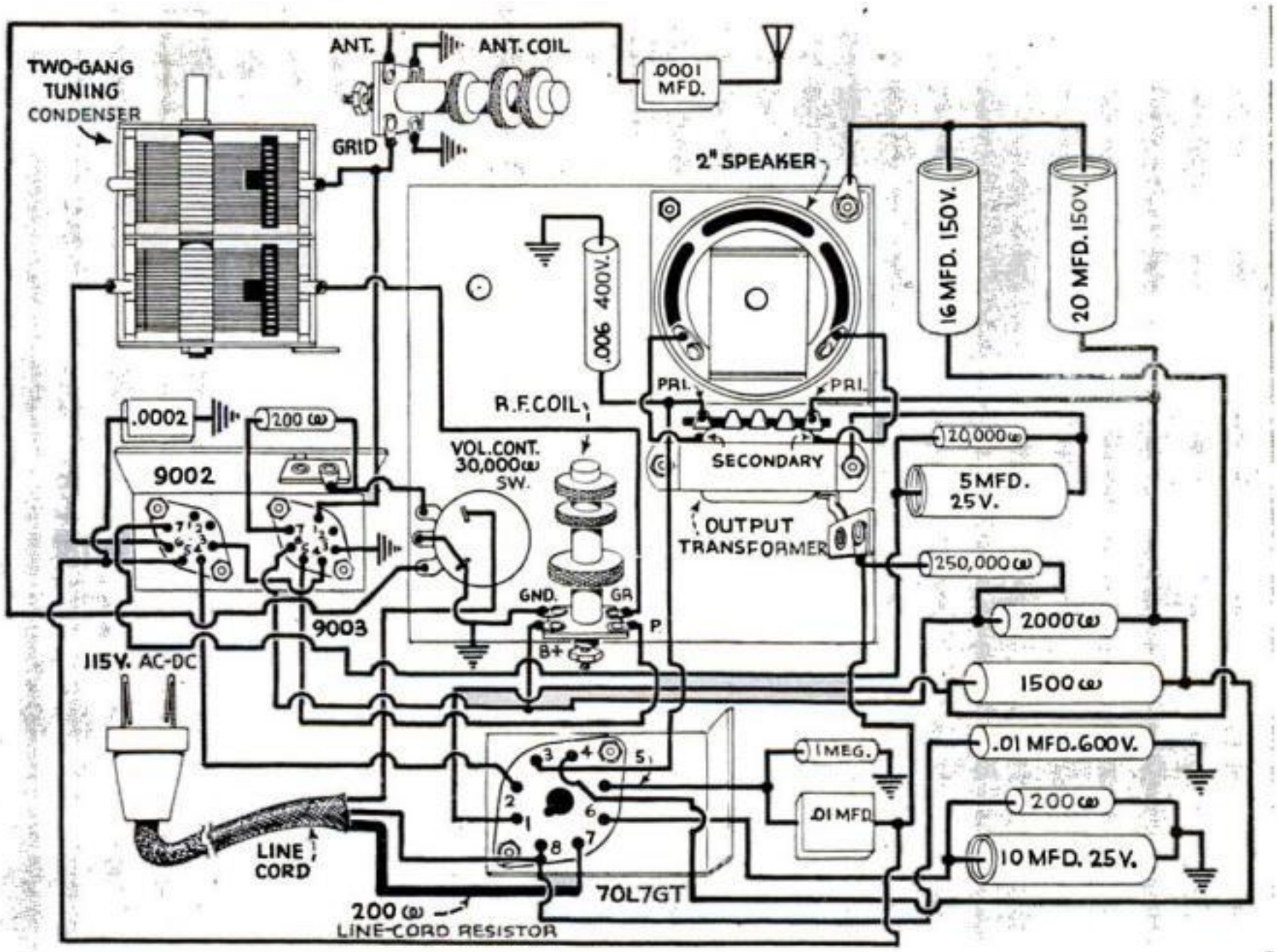
Making use of the new tiny electric tubes and iron-core coils, the set pictured on these pages was mounted on a front panel (no chassis was used) of unusual design and measuring only 4¾″ square. In the upper left-hand corner a circle 2⅛″ in diameter was punched out for the speaker. Beside it, on the upper right-hand side, and mounted directly on the front panel, is a .00036-mfd,



Front view of panel on which receiver is mounted



Close-up of the wiring. All parts are accessible

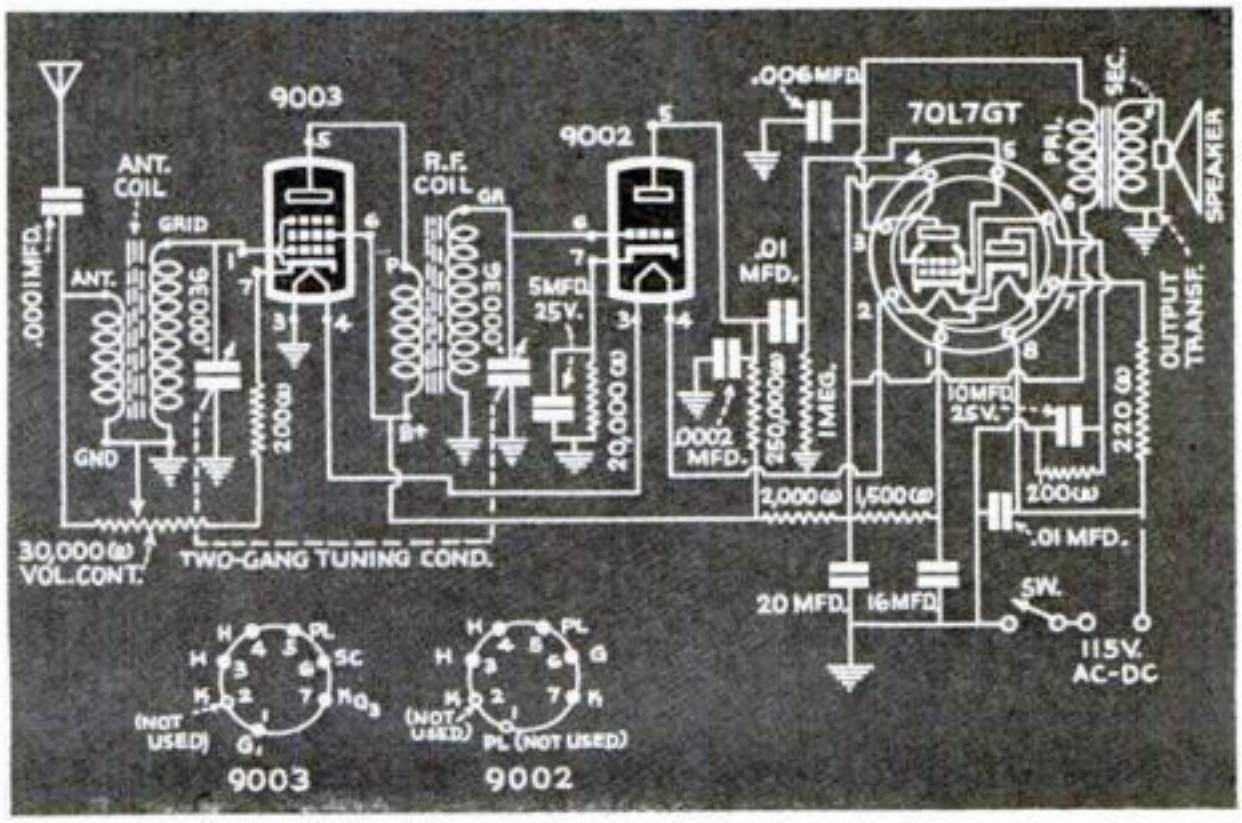


In this pictorial diagram, the compact placing of the parts of the midget receiver is shown in detail

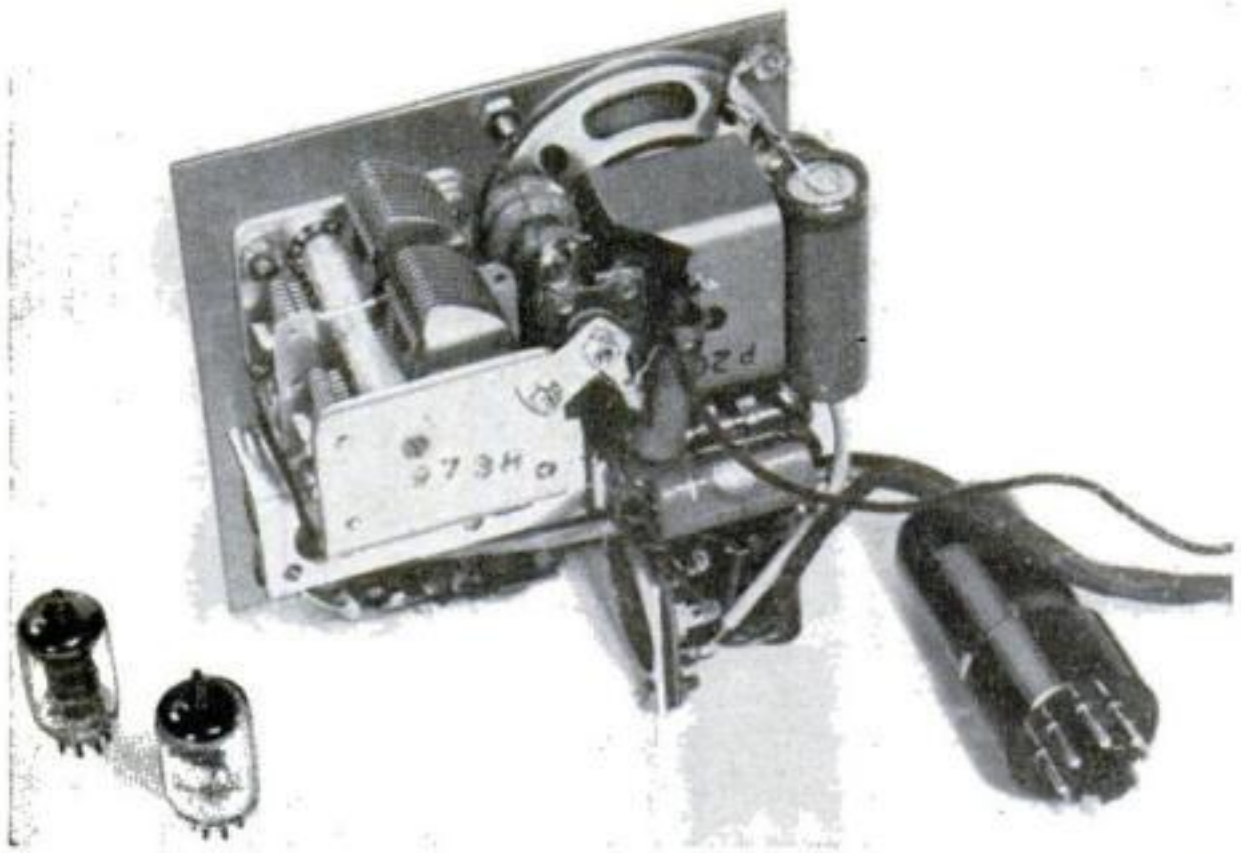
two-gang tuning condenser. Clamped to the framework of the tuning condenser by means of two 6-32 machine screws, ¼" long, is a small bracket on which were mounted the midget seven-prong wafer sockets for the tiny RF pentode amplifier (9003) and the high-mu detector triode (9002). Another bracket was used for mounting the standard-size eight-prong socket of the 70L7GT tube, which is a combination power pentode and half-wave rectifier. The midget output transformer, coupling the pentode portion of the 70L7GT tube to the 2" speaker, was mounted directly under the speaker.

The iron-core antenna coil was mounted on the two-gang tuning condenser just next to the speaker. The RF coil was mounted next to the bracket holding the 70L7GT tube. A 50,000-ohm variable resistor acts as a volume control and was put in place on the front panel directly under the two-gang condenser.

The four-stage TRF circuit which is used in this midget receiver consists of a tuned RF stage coupled to a biased detector stage, which in turn is resistance coupled to the beam power pentode. A half-wave rectifier furnishes plate voltage to the tubes, and this plate supply is amply filtered by the 2,000- and 1,500-ohm, 2-watt resist-

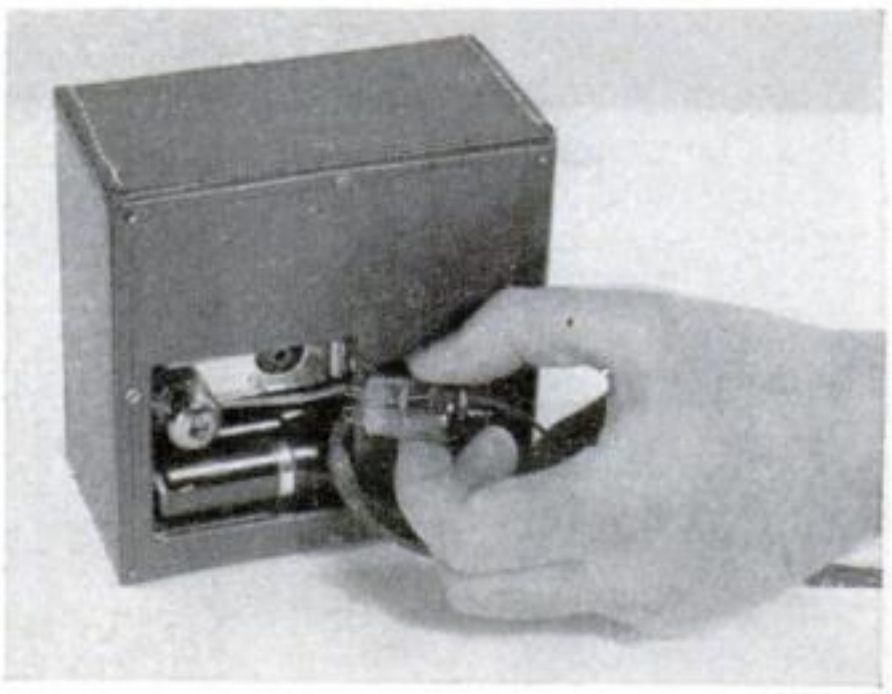


Complete wiring diagram, including base layouts (at bottom) for tubes



Back view of receiver, wired but with the tubes removed. The RF coil, mounted on the metal panel by means of a ¾" angle bracket, is shown just next to the 50,000-ohm variable resistor. The 9002 midget high-mu triode tube and 9003 pentode are at left

Leather-covered cabinet from the rear. The opening at the lower left corner ventilates the three tubes and is 2¼" square. The back cover is a piece of heavy cardboard and leather held by four screws



ors, the 20-mfd. and 16-mfd., 150-volt electrolytic condensers, and the .01-mfd. paper tubular condenser (400 volts) in the plate circuit of the rectifier.

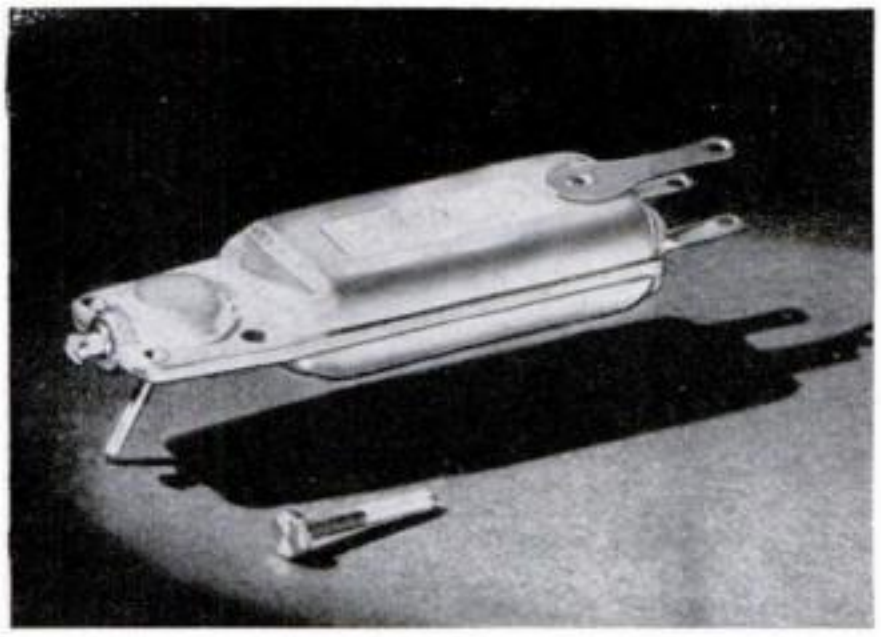
The new midget tubes used employ mount structures similar to those of the older Acorn tubes, but the new ones have glass button bases which provide short leads and low-lead induction. Each tube employs two cathode leads which cause a reduction in input loading and provide an increased gain. The single-ended design of the new tubes has the added advantage of requiring a minimum mounting space. Although these tubes were designed primarily for use by engineers, experimenters, and amateurs working in the ultra-high frequencies, they can also be used for operation in a receiver designed for service in the regular broadcast band.

When completed, the receiver and its front-panel mounting were placed in a small wooden cabinet covered with cowhide leather stitched at the corners. The outside dimensions of the cabinet used were 5 3/16" by 5 3/16" by 2¾". A heavy piece of cardboard, also covered with leather, was used for the back cover. This cover was held in place by four small brass wood screws. An opening 2¼" square was cut in the back cover to make allowance for the necessary ventilation of the tubes.

As this is an AC-DC receiver and therefore already grounded through the electric outlet, no further ground connection was needed. If a ground should be used it must be connected to the receiver through a .1 mfd., 400-volt tubular paper condenser, otherwise a short will occur, blowing out the tubes. Only a short antenna (about 15') is employed and may consist of stranded S.C.C. wire strung along the floor.

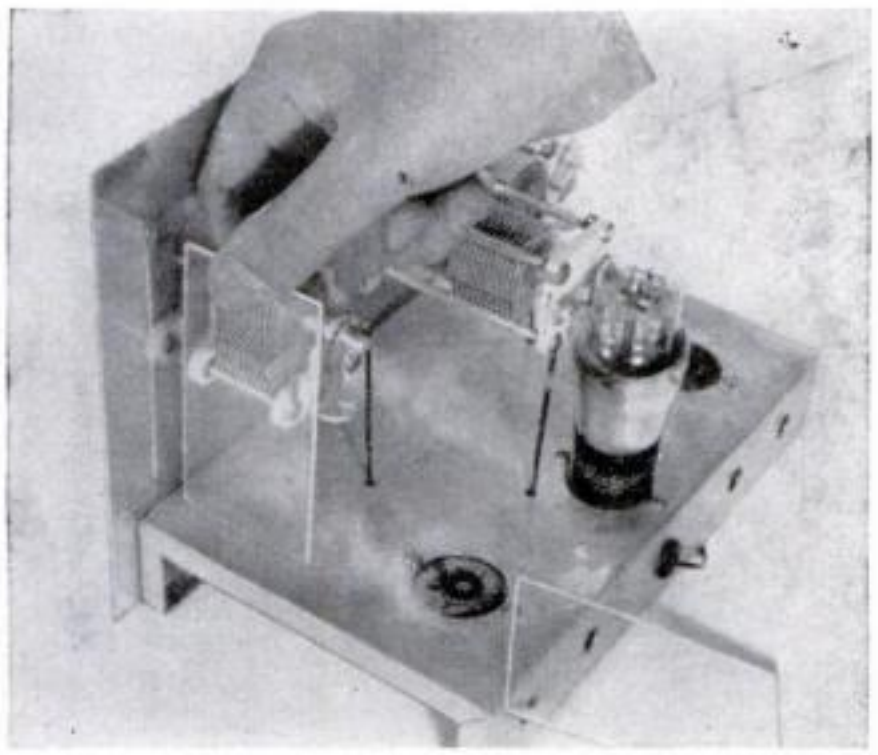
LIST OF PARTS

Cabinet, 5 3/16" by 5 3/16" by 2¾".
Two-gang tuning condenser, .00036 mfd.
Iron-core antenna and RF coils.
Midget permanent-magnet 2" speaker.
Midget output transformer.
Midget tubes (two): Super-control pentode, 9003; high-mu triode, 9002.
Pentode-rectifier tube, 70L7GT.
Line cord resistor, 220 ohms.
Variable resistor, 50,000 ohms.
Plate cover switch, S. P. S. T.
Electrolytic condensers (four): 20 mfd., 150 volts; 16 mfd., 150 volts; 5 mfd., 50 volts; 10 mfd., 25 volts.
Mica condensers (three): .0001 mfd.; .0002 mfd.; .01 mfd.
Tubular condensers (two): .006 mfd., 400 volts; .01 mfd., 600 volts.
Carbon resistors (seven): ½ watt, 20,000 ohms; ½ watt, 250,000 ohms; ½ watt, 200 ohms; ½ watt, 1 megohm; 1 watt, 200 ohms; 2 watts, 2,000 ohms; 2 watts, 1,500 ohms.
Midget wafer sockets: Seven prong (two), eight prong (one).

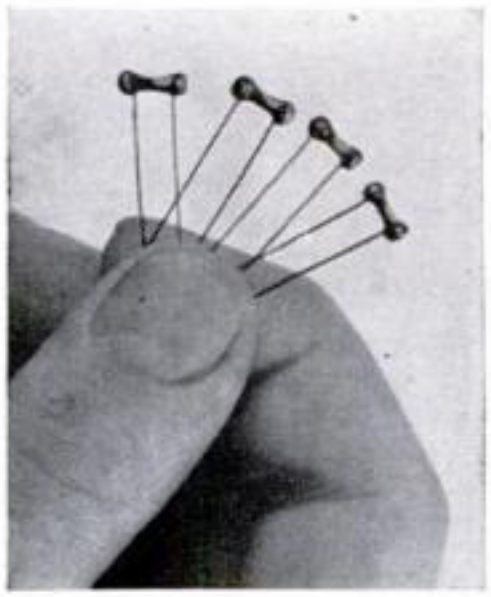


Radio Ideas

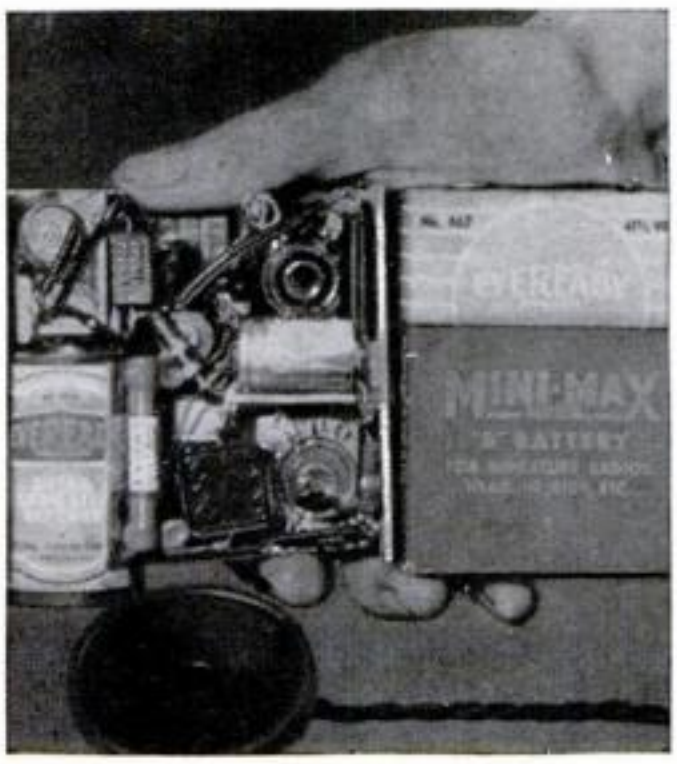
CRYSTAL PICKUP CARTRIDGES of high voltage and low pressure are now designed for permanent-point needles. With only one-ounce needle pressure, this flat-type cartridge permits lifelike reproduction of full frequency range. Built in a sturdy lightweight metal case, it is said to save record wear and improve performance. A setscrew permits locking the needle in place. The cartridge is available either with or without the needle.



DUST COVERS of flexible, transparent plastic are available for protecting exposed parts in a radio. This new material may be had in thicknesses from .001″ to .060″. It is easily cut to the proper size with scissors or a small-tooth saw. Noisy tuning, caused by grit and grime between the plates of a variable condenser, is eliminated when the condenser is covered with the plastic, which, being flexible, may also be used around coils to protect the windings from dust and other damage.



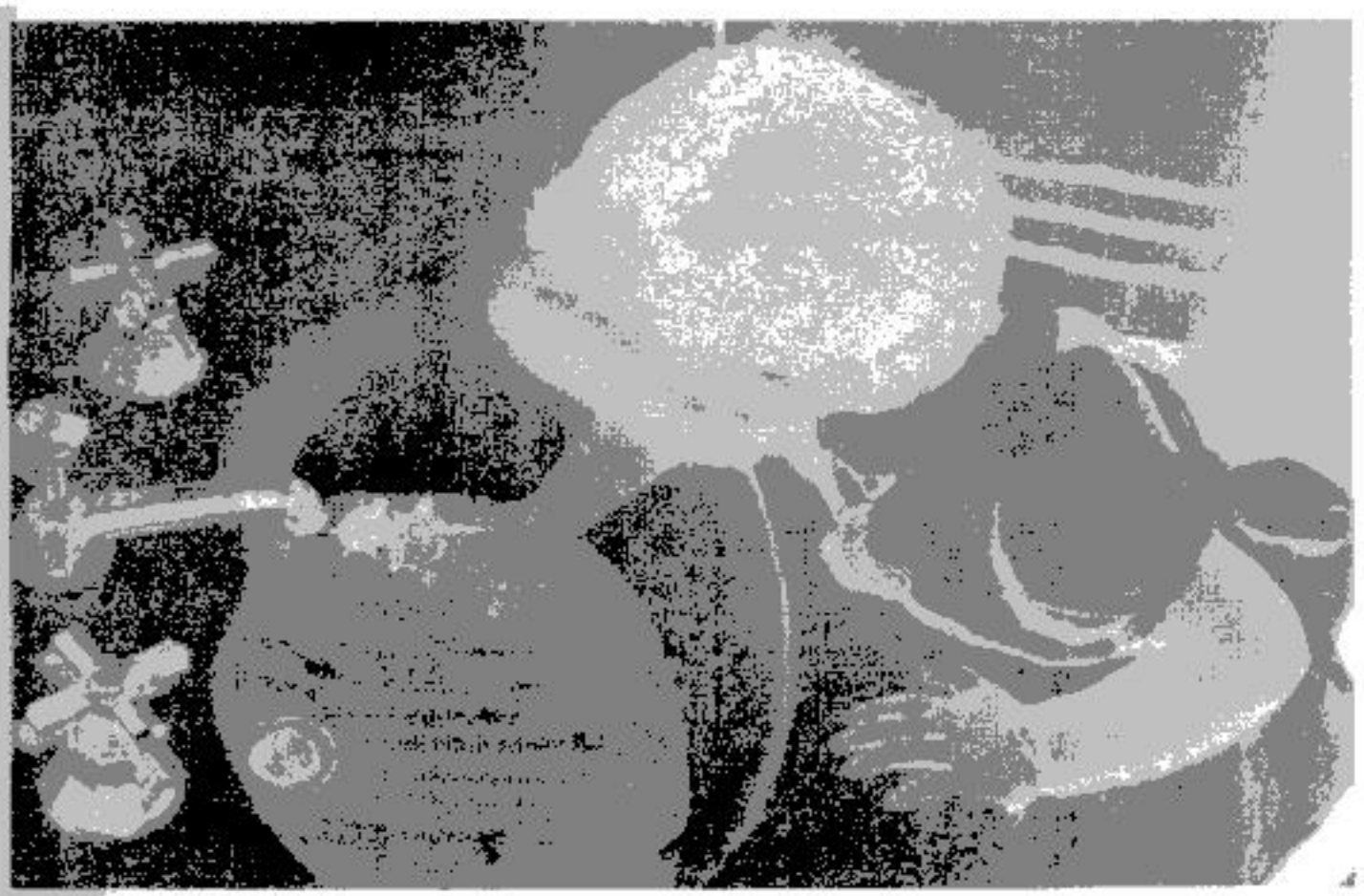
STRAPPED TO HIS BELT, a short-wave receiver is standard equipment for a motorcycle policeman in Atlantic City, N. J. The set is housed in a small aluminum box, a leather case contains a "B" battery, and a wire over the shoulder serves as an antenna. The apparatus weighs two pounds.



MIDGET ¼-WATT RESISTORS 5/16″ long and 1/16″ in diameter are now available. They are color coded and fully insulated, and are not affected by humidity. Useful in short-wave sets, they have a low noise level and the effect of radio frequency on the resistance is negligible at frequencies up to 30 megacycles.

First Aid

A poor print—washed out, with chalky whites, and devoid of the gradation and middle tones that are so necessary to impart roundness, texture, and delineation. Below is shown the negative, which was overexposed and overdeveloped. Most details are lost and the density is far too great



This is the same negative shown at the bottom of the facing page after it had been corrected by reduction of overall density and excessive contrast. At left, print from corrected negative made on normal paper without manipulation. Note fine detail, gradation, and tonal values, which produce roundness

FOR AILING NEGATIVES

HOW TO USE VARIOUS METHODS OF REDUCTION AND INTENSIFICATION TO SAVE PICTURES THAT ARE IMPROPERLY EXPOSED OR POORLY DEVELOPED

By Henry M. Lester

Editor of the *Photo-Lab-Index*

IF A NEGATIVE is blurred or out of focus, or if it has been doubly exposed, there isn't very much you can do with it . . . throw it away! However, if a negative is sharp and otherwise good, except that it "simply won't print" because it is too dense and contrasty, or too thin and weak, the case is not at all hopeless; it can be made to yield prints of good quality by one of several methods, generally involving either *reduction* or *intensification*. Both are simple chemical treatments, usually requiring no darkroom. The chemicals needed are comparatively inexpensive and may be obtained either as separate ingredients or in the form of prepared compounds that need only be added to a stated amount of water.

Reduction and intensification produce diametrically opposite effects upon the metallic silver deposit which forms the image of the negative. The first will dissolve away excessive silver deposit, while the second will build up the deposit where the negative is too thin and weak.

Unsatisfactory negative densities are caused by various factors. Overexposure alone or together with overdevelopment produces negatives that are too dense; underexposure, with or without underdevelopment, results in negatives that are too thin and weak. Of the many types of reducers and intensifiers, each is different in its performance and useful for correcting one or more of these faults. None is a cure-all. Knowledge of performance characteristics of a given formula, combined with the correct diagnosis of the defect, enables the photographer to select suitable treatment and obtain the desired correction. The most generally useful formulas, together with notes as to what they may be expected to accomplish and instructions for their use, will be found grouped on a following page.

Before you decide to reduce or intensify your negative, consider whether retaking the picture would not be simpler; if so, it is by far the better thing to do. Correcting one's error photographically (rather than chemically) will frequently fix the cause of the error in mind and lessen the likelihood of repeating it. But if the negative cannot be retaken and the picture itself is of such value that you wish to save it, the negative can be improved so that it will print well.

Reduction or intensification is effective with most photographic materials, but is

Below, print from underexposed negative. Right, print from same negative after being corrected by intensification. Center, the negative before and after treatment

chiefly employed for improving negatives, transparencies, and lantern slides. Seldom does one reduce or intensify a paper print, because it is much simpler to make a new print than it is to try to improve a bad one. While Dufaycolor transparencies can be improved to a certain degree by careful reduction or intensification, one should never attempt to correct Kodachrome transparencies in this way.

Above, a flat print from a properly exposed but underdeveloped negative. Right, a brilliant, colorful print from the negative after being corrected by intensification. Center, composite view to show what treatment did to the negative

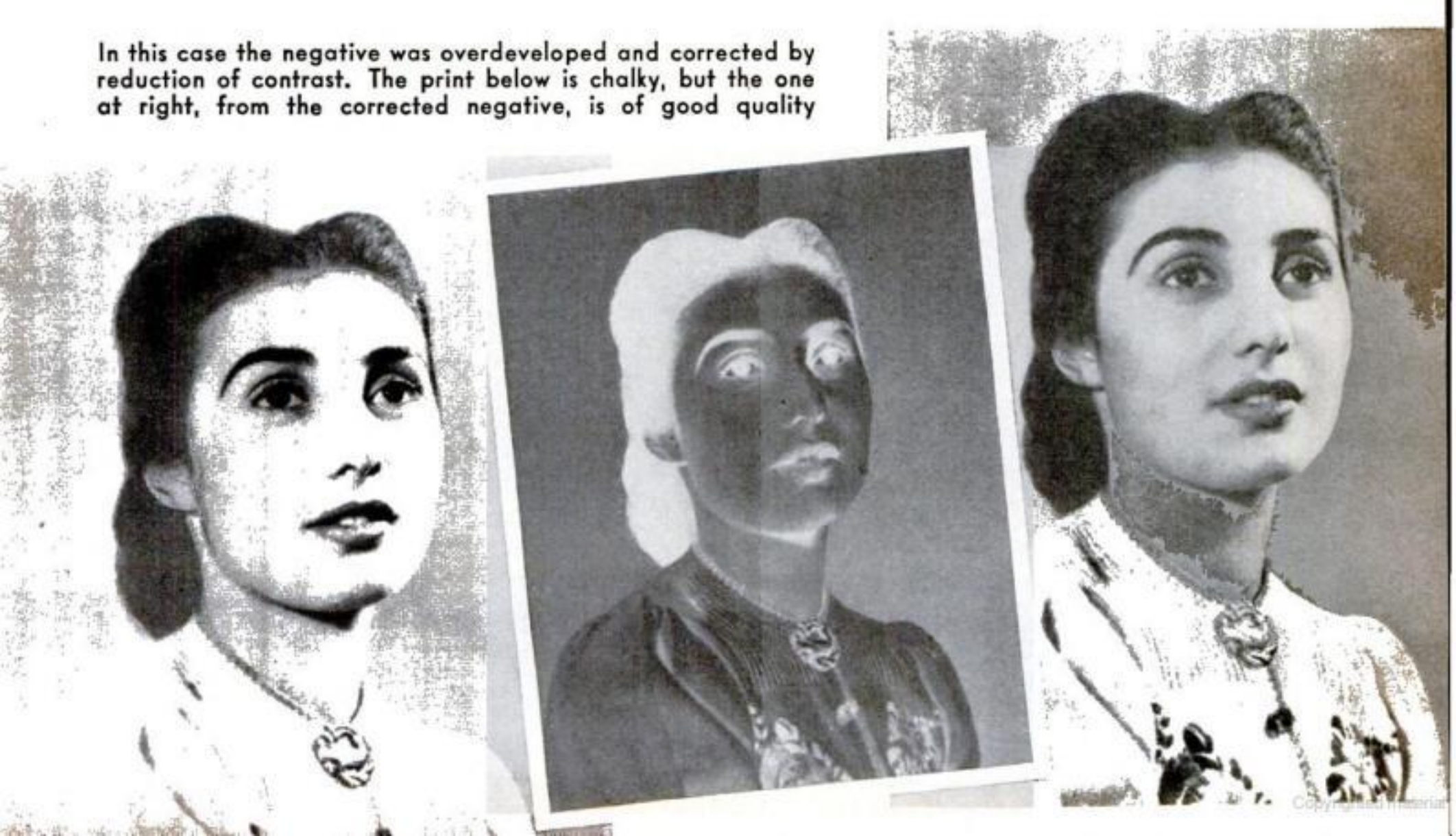
In each group in this series, the negative appears in the center. The left half shows it as it was before treatment; the right half, after treatment. Here the negative had been overexposed and was salvaged by means of reduction

REDUCER FORMULAS. These are grouped as follows according to the type of negative and correction required:

1. For correction of overexposed or fogged negatives, *subtractive* or *cutting reducers* are used. These dissolve the excess silver in an equal degree from the high, intermediate, and low densities. By clearing up shadow areas, they appear to increase contrast. An excellent one of this type is Farmer's reducer No. 1 in the group of formulas on the following page.

2. For correcting overdeveloped negatives, *proportional reducers,* thus called because they reduce silver density in proportion to the original density of the negative, are used. These lessen the actual contrast, which is usually caused by overdevelopment. The two-solution Farmer's reducer (formula No. 2) is typical of this type. *(Continued)*

In this case the negative was overdeveloped and corrected by reduction of contrast. The print below is chalky, but the one at right, from the corrected negative, is of good quality



FORMULAS FOR REDUCTION AND INTENSIFICATION

1. FARMER'S REDUCER

Stock solution A		
Potassium ferricyanide	275 grains	18.75 grams
Water to make	8 oz.	250 cc.
Stock solution B		
Sodium thiosulphate (hypo)	8 oz.	240 grams
Water to make	32 oz.	1 liter

A cutting reducer for correcting overexposed negatives and clearing shadow areas. To use, add 1 oz. (30 cc.) of solution **A** to 4 oz. (120 cc.) of solution **B**. Add water to make 32 oz. (1 liter). Pour at once over the negative to be reduced, preferably in a white tray, and watch the action closely. When the negative has been reduced sufficiently, wash it thoroughly before drying. Solutions **A** and **B** must not be mixed until they are to be used.

2. TWO-SOLUTION REDUCER

Solution A		
Potassium ferricyanide	¼ oz.	7.5 grams
Water to make	32 oz.	1 liter
Solution B		
Sodium thiosulphate (hypo)	6¾ oz.	200 grams
Water to make	32 oz.	1 liter

A proportional reducer for correcting overdeveloped negatives and lessening contrast. The two solutions are not mixed, but used separately. Treat the negative in solution A with uniform agitation for 1 to 4 minutes, depending upon the degree of reduction desired, at 65 to 70 deg. F. (18 to 21 deg. C.). Immerse it in solution B for 5 minutes, then wash it thoroughly. The treatment may be repeated if more reduction is desired. For the reduction of general fog, dilute 1 part of solution A with 1 part of water. This solution will keep indefinitely if shielded from bright daylight.

3. PERSULPHATE REDUCER

Stock solution		
Water	32 oz.	1 liter
Ammonium persulphate	2 oz.	60 grams
Sulphuric acid, C.P.	¾ dram	3 cc.

Warning: Add the acid slowly to the water, never the water to the acid, as dangerous spattering may otherwise result.

A super-proportional reducer for correcting overdeveloped negatives of contrasty subjects. To use, add 1 part stock solution to 2 parts water. Treat the negative in formalin hardener (formula No. 7) and wash it thoroughly, then immerse it in the reducer until the action has progressed as far as desired. Leave the negative in an acid fixing bath for a few minutes, wash thoroughly, and dry. If reduction is too rapid, add more water to the reducer.

4. MERCURY INTENSIFIER

Potassium bromide	¾ oz.	22.5 grams
Mercuric chloride	¾ oz.	22.5 grams
Water to make	32 oz.	1 liter

Bleach the negative in this solution until it is white, then **wash thoroughly** and redevelop in one of the following: a 10% sulphite solution, a developer such as D-72 diluted 1 to 2, or a 10% ammonia solution (1 part concentrated or 28% ammonia to 9 parts water). These three redeveloping agents produce increasingly greater density in the order given. To increase contrast greatly, treat with the following:

Solution A		
Water	16 oz.	500 cc.
Sodium cyanide	½ oz.	15 grams
Solution B		
Water	16 oz.	500 cc.
Silver nitrate, crystals	¾ oz.	22.5 grams

Warning: Cyanide is a deadly poison. Handle with extreme care, wearing rubber gloves, and avoid breathing its fumes. When discarding the solution, run water to flush it out of the sink quickly. Never use any cyanide solution in a poorly ventilated room.

Mercury intensifier is recommended where extreme intensification is desired, but where permanence of the image is not essential. Redevelopment cannot be controlled, but must go to completion.

Add solution **B** to solution **A** until a permanent precipitate is just produced; allow the mixture to stand a short time, then filter. This is called Monckhoven's intensifier.

5. CHROMIUM INTENSIFIER

Stock solution		
Water	24 oz.	750 cc.
Potassium bichromate	3 oz.	90 grams
Hydrochloric acid, C.P.	2 fl. oz.	64 cc.
Add cold water to make	32 oz.	1 liter

Negatives treated with chromium are more permanent than those intensified with mercury. Add 1 part of stock solution to 10 parts of water. The negative must be hardened in a formalin solution (formula No. 7) before treatment, otherwise reticulation may ruin it. Immerse it in the chromium solution at 65 deg. F. (18 deg. C.) until thoroughly bleached, then wash it 5 minutes and redevelop fully by artificial light or weak daylight in any quick-acting, nonstaining developer containing no excess of sulphite, such as D-72, diluted 1 to 3. Rinse, fix for 5 minutes, and wash thoroughly. Further intensification can be obtained by repetition.

6. SILVER INTENSIFIER

Stock solution No. 1 (Store in a brown bottle)		
Silver nitrate, crystals	2 oz.	60 grams
Distilled water to make	32 oz.	1 liter
Stock solution No. 2		
Sodium sulphite, desiccated	2 oz.	60 grams
Water to make	32 oz.	1 liter
Stock solution No. 3		
Sodium thiosulphate (hypo)	3½ oz.	105 grams
Water to make	32 oz.	1 liter
Stock solution No. 4		
Sodium sulphite	½ oz.	15 grams
Elon (Metol, Pictol, Rhodol)	350 grains	24 grams
Water to make	96 oz.	3 liters

This is the only intensifier known that will not change the color of the image; it is therefore equally suitable for positive and negative film. It gives proportional intensification, which is easily controlled by varying the time of treatment.

Slowly add 1 part of solution No. 2 to 1 part of solution No. 1, shaking or stirring well meanwhile. The white precipitate that appears is then dissolved by the addition of 1 part of solution No. 3. Allow the resulting mixture to stand a few minutes until clear, then add, with stirring, 3 parts of solution No. 4. Immediately immerse the film to be treated, and leave it in until the desired intensification is produced, but in no case longer than 25 minutes. After intensification, immerse the film for 2 minutes with agitation in a plain 30% hypo solution, then wash thoroughly. Once mixed, the above intensifier is stable for approximately 30 minutes.

7. FORMALIN HARDENER

Water	16 oz.	500 cc.
Formaldehyde (40%)	2½ drams	10 cc.
Sodium carbonate, desiccated	73 grains	5 grams
Water to make	32 oz.	1 liter

Treatment in this hardener is strongly recommended for films that are to be intensified or reduced. After immersion for three minutes, negatives should be rinsed and immersed for five minutes in a fresh acid fixing bath, then washed thoroughly before they are given any further chemical treatment.

3. For correcting overdeveloped negatives of contrasty subjects, there is the *superproportional reducer,* which has the property of reducing high-light density without affecting shadow detail. The acid-persulphate reducer (formula No. 3) is such an agent.

INTENSIFIER FORMULAS. To increase the amount and density of the image-forming deposit and to produce adequate contrast, the various intensifiers deposit some finely divided substance on the silver image. A number of substances are used for this purpose, among them uranium, silver, mercury, and chromium compounds. The effects produced by these differ chiefly in the degree of permanence and color of the deposit. Mercury compounds are capable of producing maximum intensification and contrast, which, however, are not very stable. On the other hand, chromium compounds work with great ease and certainty, and produce permanent intensification. Silver compounds, because they do not alter the color of the image, are preferred for intensifying positive transparencies and lantern slides. Typical of these three types of intensifiers are formulas Nos. 4, 5, and 6.

The use of reducing and intensifying formulas is simple, but certain precautions ought to be observed. Many of the ingredients are highly poisonous. They should be handled carefully in well-ventilated rooms and *stored out of reach of other members of the household.* To prevent the formation of stains during intensification, always observe the following rules:

1. Fix and wash the negative thoroughly before treatment. Be sure it is free of scum or stains.

2. Harden the negative before treatment in a formalin hardener, such as the one given in formula No. 7.

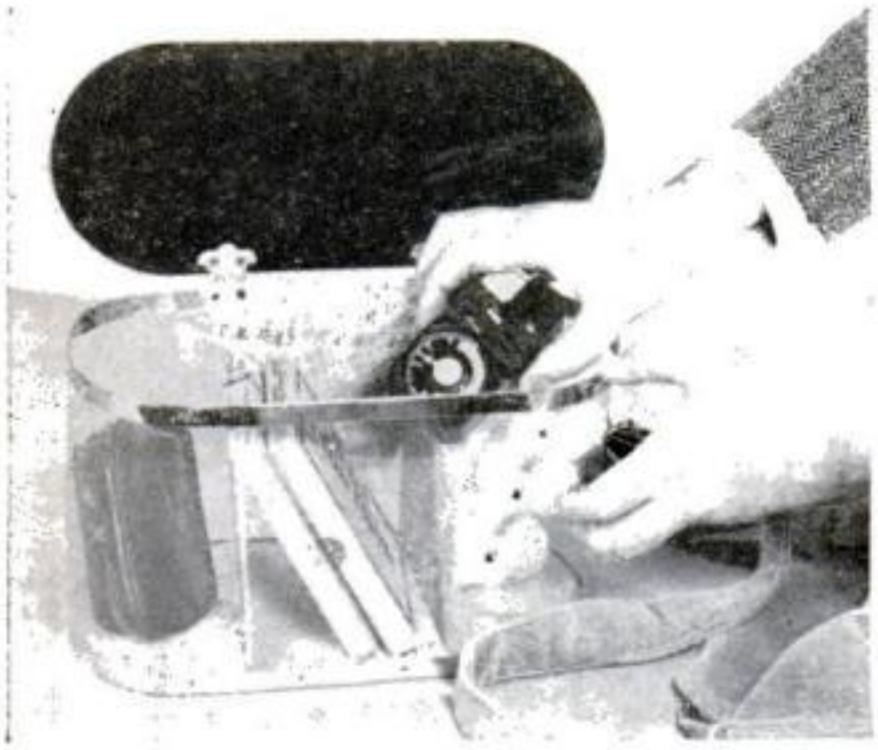
3. Handle only one negative at a time, and thoroughly agitate it during treatment. Thoroughly wash and carefully wipe it before drying.

For those who have not done much of this work before, a good plan is to employ a transparent glass tray or dish, placed over some source of weak light. This arrangement will enable the operator to observe the progress of the action and interrupt it at the right moment. Trays and dishes should be carefully cleaned of all traces of solutions before being put away. Utmost cleanliness should be observed throughout all the various steps.

In general, all sizes of negatives can be satisfactorily treated by reduction and intensification. However, in the case of miniature camera negatives, it should be remembered that intensification increases the size of the grain considerably.

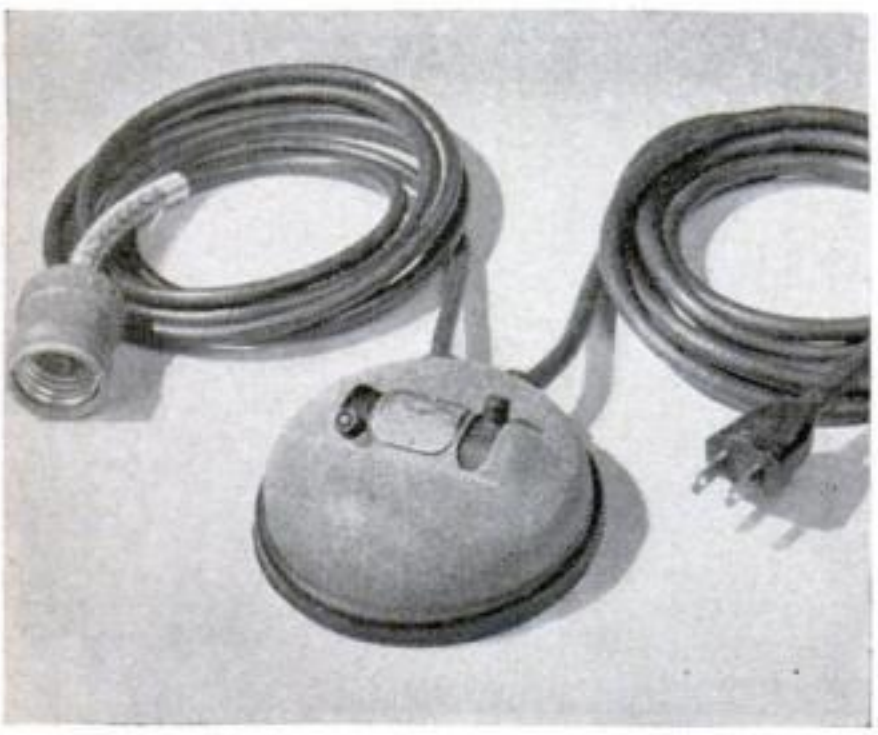
This set of illustrations is another example of what can be done with an overdeveloped negative. It was corrected through treatment in a cutting reducer. The print from the corrected negative (at right) is superior in detail and tonal values to the flat print (at left) made from the negative before reduction

FOR CAMERA USERS



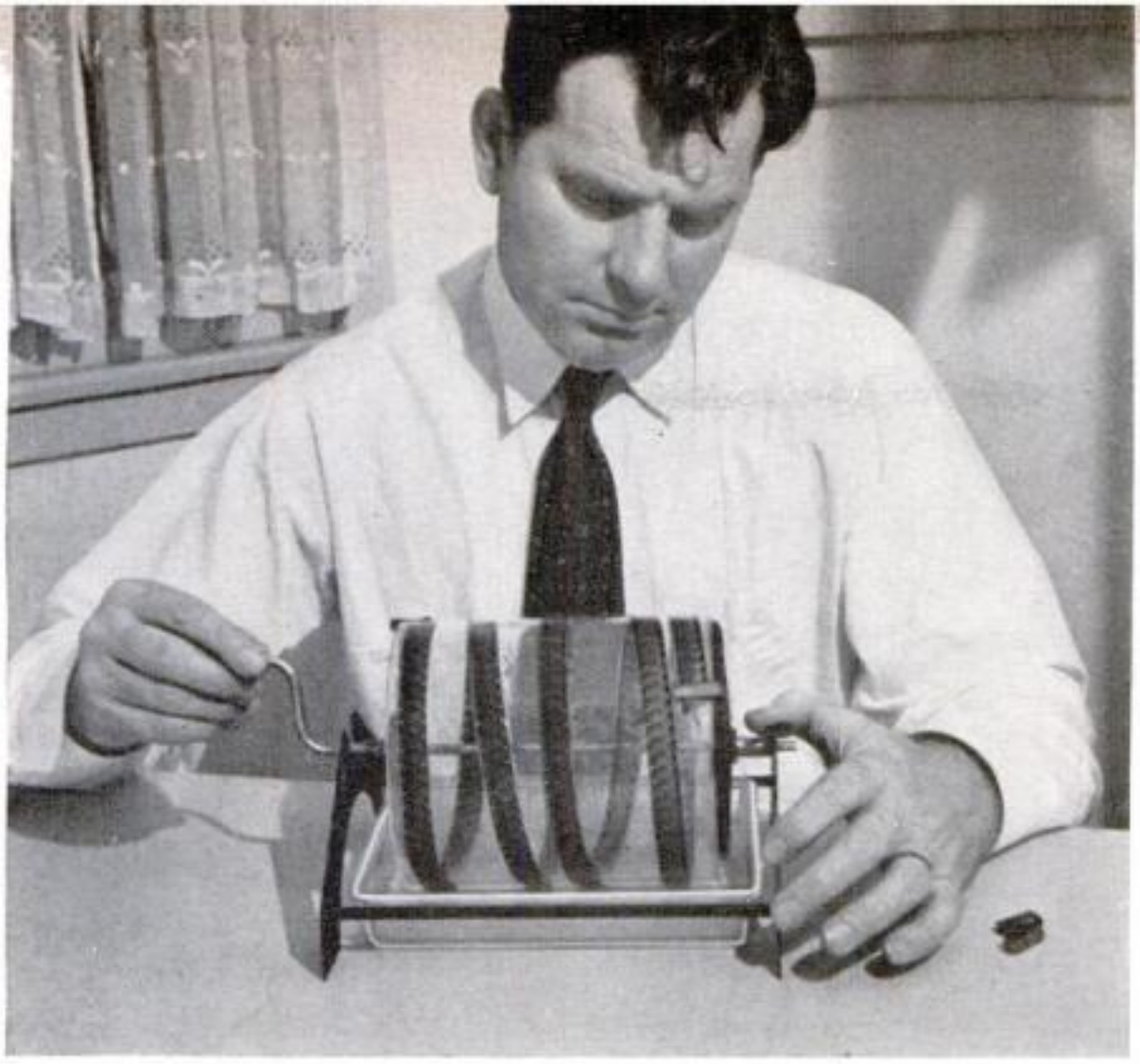
A DOUBLE-DUTY STORAGE CASE and carryall has been placed on the market for cameras of any size up to the 9 by 12 cm. film-pack models and their accessories. The case has three compartments with ample room for flash bulbs, filters, a light meter, and several rolls or packs of film, besides the camera. The walls are transparent so that the contents are ordinarily visible at a glance. For outdoor use, however, a corduroy cover with an adjustable shoulder strap is slipped over the outfit, as shown above.

THREE LIGHT INTENSITIES for enlarging are at the user's finger tips with a new table-top mercury switch (below) for use with double-filament bulbs. Unlike a rheostat, which alters the color of the light, the switch cuts in either one or both of two filaments, each at the correct temperature to provide white printing light, affording light intensities of 50, 100, and 150 watts, and enabling the operator to match the light to the density of the negative. Silent, nonsnap mercury contacts eliminate all danger of vibration in the enlarger.



BLACKOUT EQUIPMENT has been developed to assist in taking flash photos on infra-red film in total darkness. The new reflector has a detachable visor and a gold-finish interior designed to reflect infra-red rays. It is intended for use with the new blackout flash lamps and any type of flash gun, and is effective in daylight as well as at night.

Tinting Movie Film at the Kitchen Sink



You need no darkroom to tone or dye movie film, but can work in the kitchen. About 7' of film can be handled with ease on the reel shown

By CHARLES G. CLARKE, A.S.C.

AMATEUR movie makers may obtain beautiful color effects at small cost by toning and dyeing black-and-white film. Flaming sunsets, blue skies, waterfalls, green pastorals, and even portraits and interiors can be made to sparkle with a touch of color. No darkroom is necessary.

Toning chemicals color the image only, while dyes impregnate the whole emulsion. Both are available in a range of colors. To apply any of them is as simple as immersing film in a sulphide solution to get sepia tones. Similarly, other chemicals turn high lights or shadows blue, green, copper or red. Most photographic manuals supply formulas, but commercial concentrated colors in either powder or liquid form require only the addition of water.

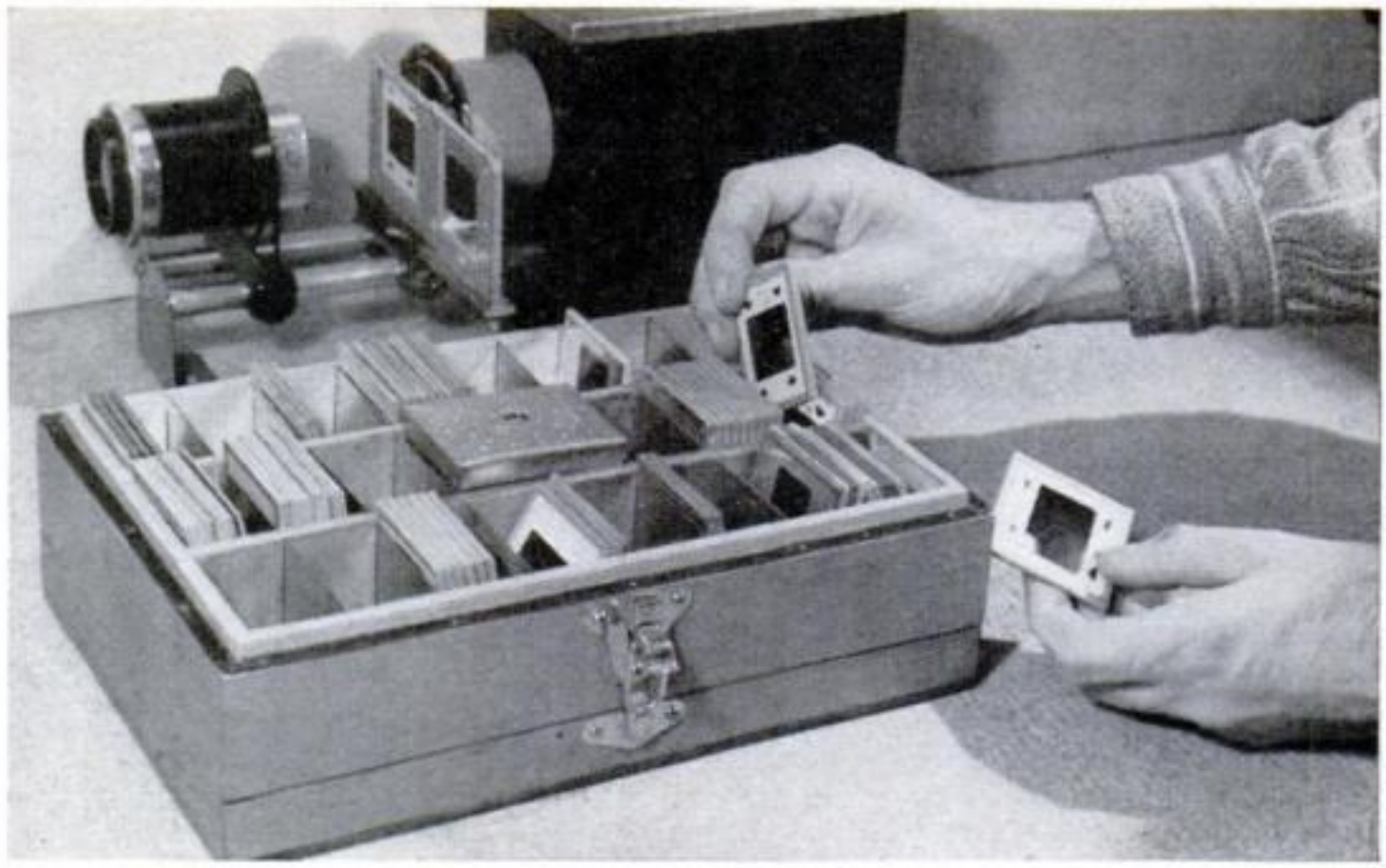
An open glass drum or a tank may be used, depending upon the length of the film. If the film has been projected, wash it in a weak solution of acetic acid, and dry it. Then wind it, emulsion side out, in a spiral around the drum to prevent overlapping. Pour just enough color solution into a glass tray to cover the lower surface, and revolve the drum slowly until the desired color density appears (six or seven minutes should do); then place the drum over a second tray containing water, or under a slow-running faucet, and wash the film thoroughly.

If the film is to be both toned and dyed, tone it first, wash it well, and draw it between layers of well-soaked chamois from which the moisture has just been wrung. Then revolve the drum through the dye solution.

For final drying, short and medium lengths of film may be suspended by both ends. For greater lengths, a drying drum will be needed. One may be made from two bicycle wheels with strips of varnished wood molding attached at 1½" intervals around the rims. The drum should be supported at each end by one prong of an old bicycle fork, and turned by a ¼-h.p. motor. Clip the ends of the film to elastic bands, which will take up the slack, yet give enough to permit use of the drying chamois while the drum revolves.

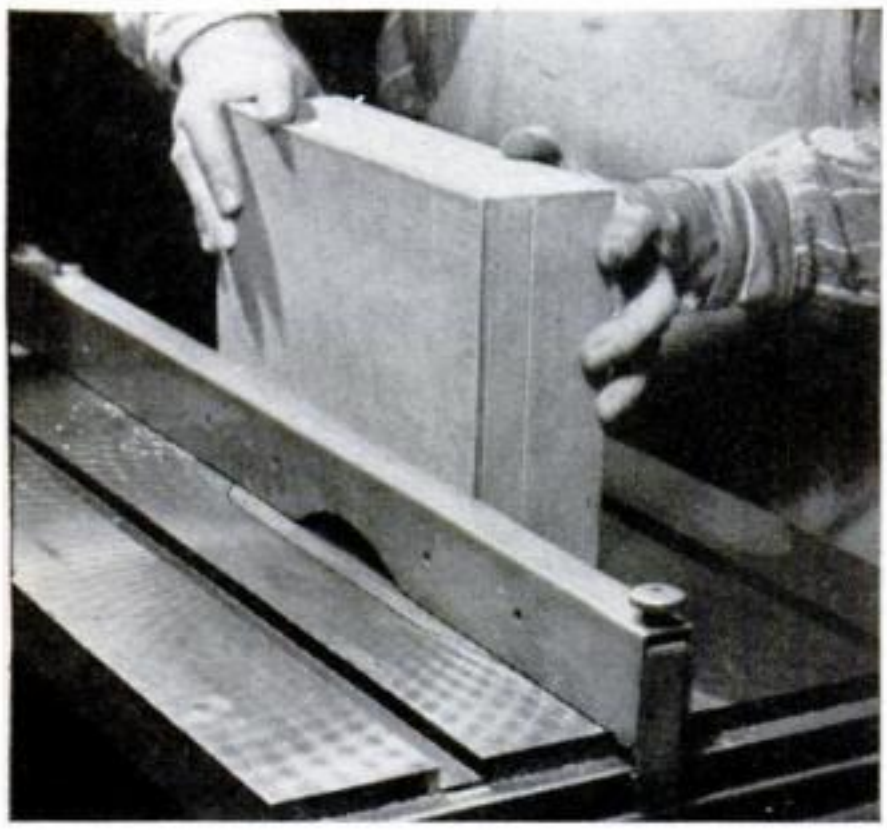
Thorough washing after treatment is important. Turn the reel in a tray of water or under a faucet stream

Below, a tank reel holds 50' of film. An embossed apron wound on with the film keeps adjacent turns separated



Valuable color transparencies can be kept under ideal conditions in a file of this type. Here the case is resting on top of the lid. Directly below, the glued box is sawed in two to form case and lid

Air-Conditioned Color-Slide File

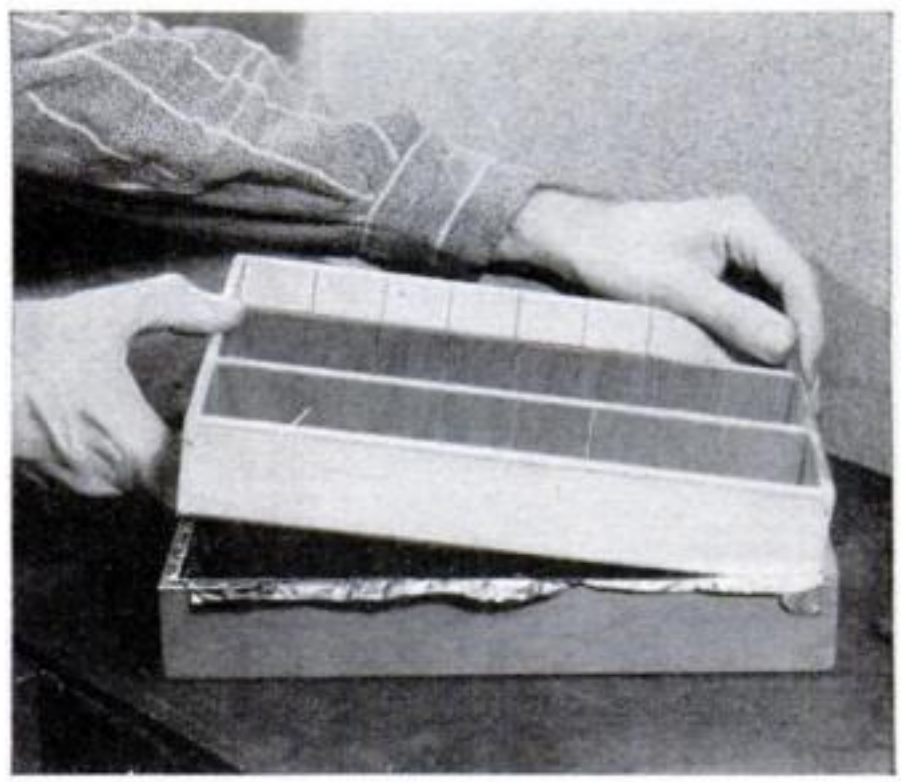


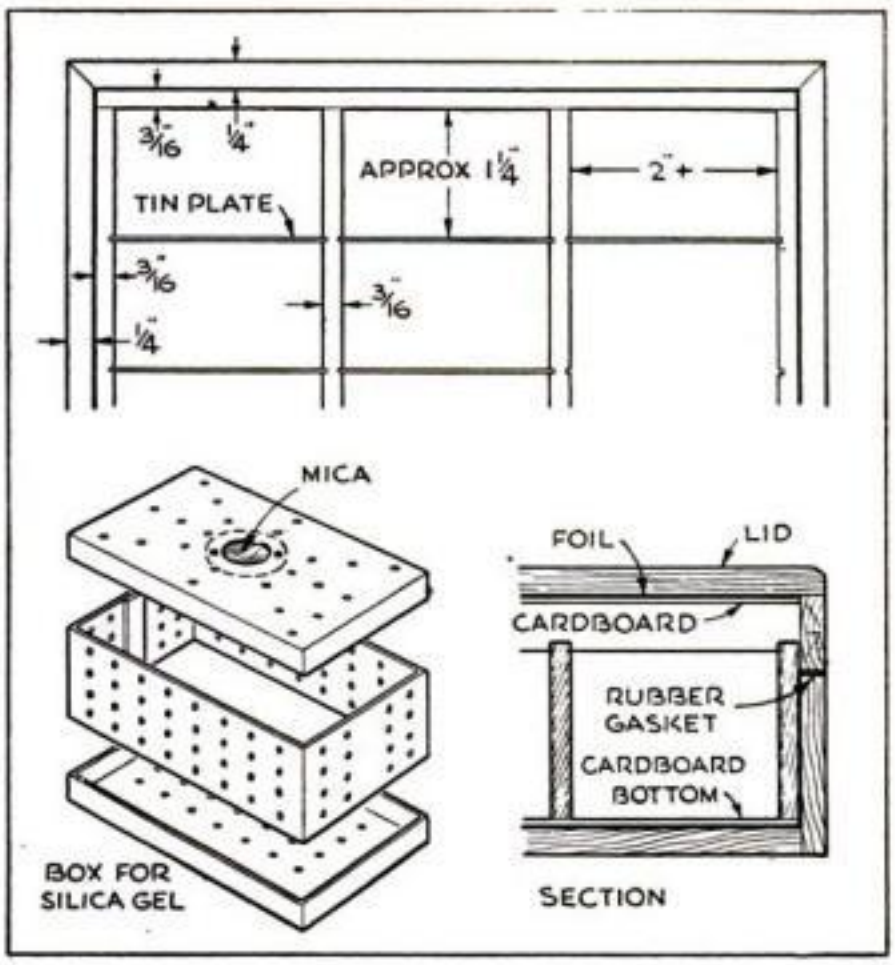
By WALTER E. BURTON

FOR long life and freedom from fading, color slides should be kept in a dry, cool place. The slide file illustrated is practically airtight, and contains a dehydrating unit that further protects the transparencies. The box is made of plywood, but other materials such as pressed composition board may be used. For ¼" stock, the outside dimensions are 2 13/16" by 7⅝" by 10¾". The corner joints are mitered. Assemble the box with casein or resin glue; then saw off the lid 1" from the top.

Line the bottom part with rubber-cemented metal foil or rubber hydrochloride

Below, applying foil lining with rubber cement and fitting the slide box proper into the outer case





film, and the lid with foil or rubber hydrochloride film covered with cardboard, or tin plate without the cardboard. The foil wrapping from photographic film is excellent. Be careful not to carry the lid lining too far down the sides. You can either cut it at the joint, as in the drawing above, or bring it down about ¼" beyond the joint.

Make an inner box of 3/16" stock, using a piece of heavy cardboard or sheet metal for the bottom. Four strips 9 13/16" long and two 7 1/16" long will be needed. Use a thin saw to cut grooves across the four longer pieces to receive tin-plate partitions. Space the grooves to divide the strips into eight equal parts. Groove both sides of two strips (omitting a center groove on one side of each), and groove only one side of the other two. These strips form the sides of three compartments slightly wider than 2" by 2" color slides, and are subdivided by pieces of tin plate into 22 spaces for the slides and one double space for the drying unit. The total capacity of the box will be about 220 slides bound between thin cover glasses, or 500 in cardboard "ready mounts."

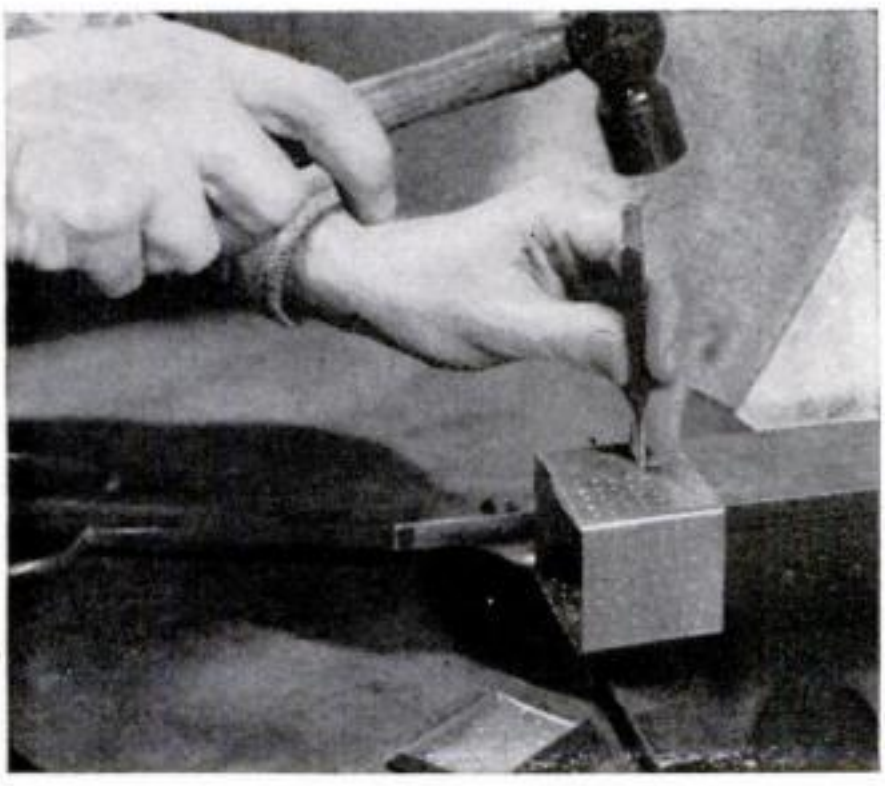
Lower the inner box into the lined outer section, trim off excess lining, and fill the crack between the two sections with plastic solder. Cut electrician's rubber tape or sponge-rubber weatherstripping into strips ¼" wide, and cement them around the top edge of the outer box; then drive in small nails, embedding the heads in the rubber.

Finish the inside with two coats of brushing lacquer, apply two coats of clear or colored lacquer to the outside and lid, and mount a small trunk fastener on each side as shown. The fasteners draw the lid tightly down against the rubber gasket and also permit it to be removed entirely when the slides are to be shown.

A 1⅞" by 2⅜" by 2" dehydrating box is made from tin plate. Liberally perforate the sides, lid, and two adjacent tin plate partitions, using a sharp punch with just enough force to break through. Fill with indicator-type silica gel. This material is blue in an "activated" state—that is, when it contains little moisture—and pink when saturated to about half its weight. It may be reactivated in an oven whenever necessary. Dry rice, slightly browned in an oven, can be used instead, but should be changed occasionally (every few weeks or oftener in summer). Rice can be made self-indicating by soaking some of the grains in a weak cobalt chloride solution before heating. A ⅜" hole in the lid, covered by a piece of mica held by two rivets, forms a window through which the color may be observed.

The dehydrating unit is a tin-plate box. Punch numerous tiny holes in the sides, top, and bottom

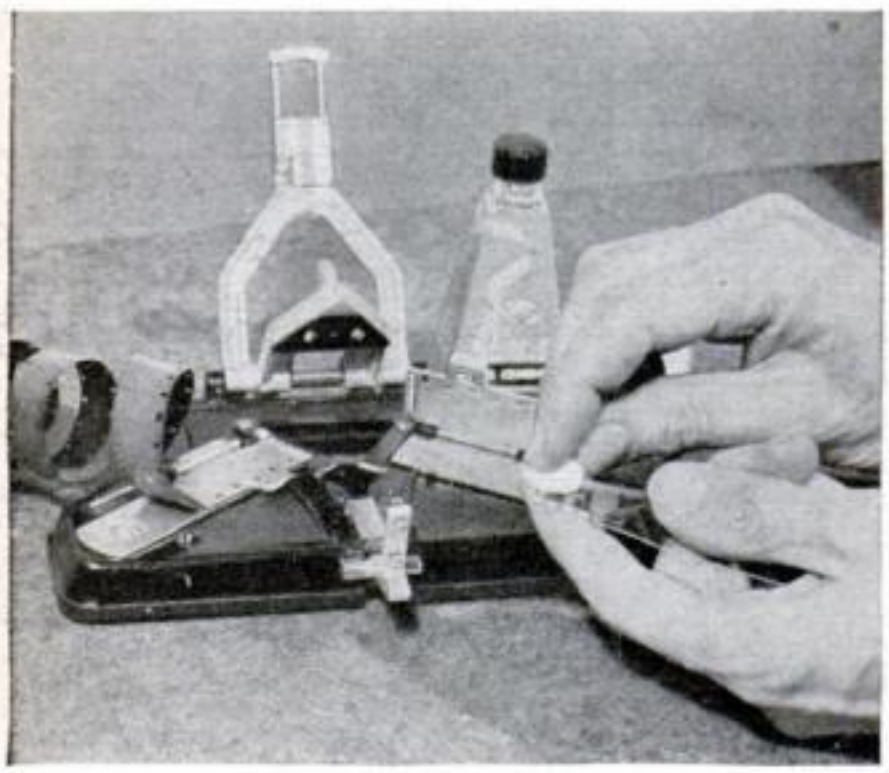
The silica gel, seen through a mica window in the lid, changes color when it requires reactivation



Level Added to Movie Camera Will Insure Straight Shots

EVEN with an accurate view finder, it is not always easy to tell when an amateur motion-picture camera is being held straight. By installing a small level somewhere on the camera body, usually on the top, the operator can save time and improve his pictures. A single-tube level will help keep the camera aligned from side to side, but it is better to use a T-shaped level or a circular one like that shown. Then the camera can be leveled in all directions. This is helpful when shooting from a tripod or when working in a locality where there are no buildings or other familiar targets at which to sight through a finder.

The photo shows a level installed on a camera by means of a threaded lug projecting from its bottom. The aluminum camera body was drilled and tapped to receive it. First, the camera was mounted on a tripod and adjusted with the aid of a large shop level; then the mounted level was tilted with pliers until the bubble rested in the center. Some household cement, previously applied under the level, was permitted to dry, thus fixing the adjustment.



Cleaning Film of Grease Aids in Obtaining Strong Splice

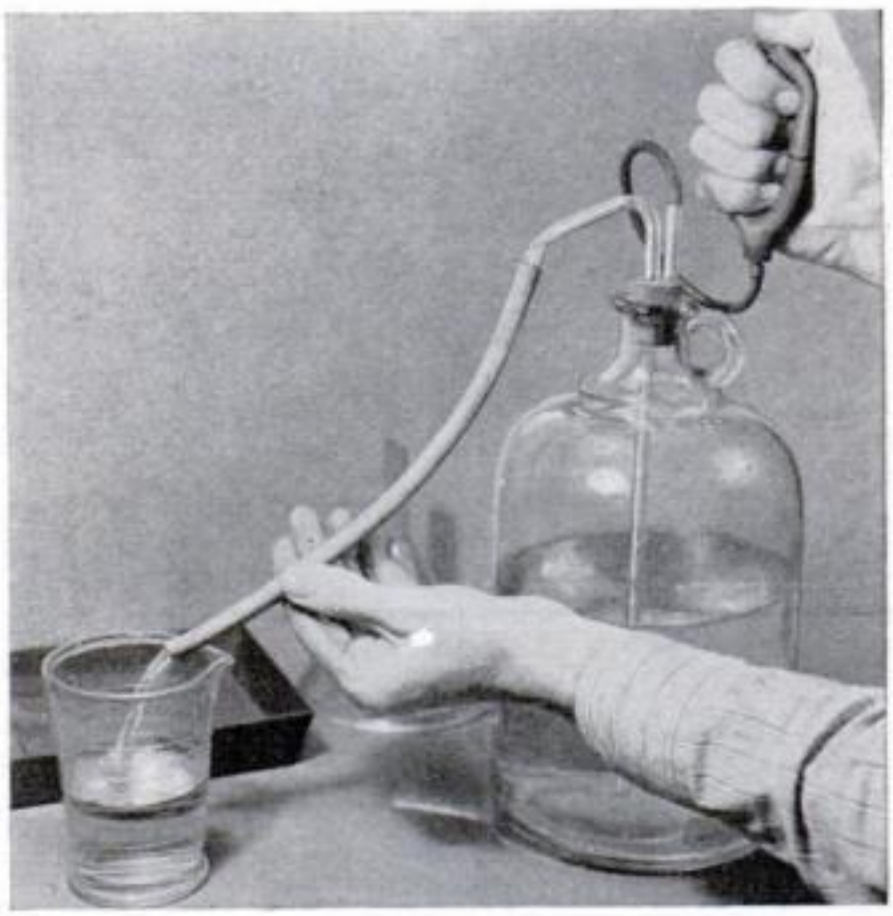
TRACES of grease or oil on the back of motion-picture film which is to be spliced will prevent the joint from attaining maximum strength. Wipe the film with a bit of cotton moistened with xylol, carbon tetrachloride, or other grease solvent before splicing it. It is not necessary to clean the scraped area of the emulsion side of the film unless it has been touched with the fingers. Fresh cotton should be employed for cleaning each splice.

• • •

IN COLOR photography, watch out for reflections from colored walls, ceilings, or backgrounds. Green, for example, may make a face look sickly.

Tube Arrangement Draws Fluid from Large Storage Bottle

A SIPHON and bulb arranged on a two-holed stopper help in drawing measured quantities of developer or other liquid from large storage jugs. The bulb—of the atomizer type, having an air valve or vent—is squeezed to pump out liquid. To stop the flow, it is allowed to expand while the thumb covers the air inlet. When the jug is well filled, a siphoning action will cause a continuous flow once it has been started.



The bent outlet tube reaches almost to the bottom of the bottle, the bulb tube only through the cork

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Gus Has an Easy Day

(Continued from page 144)

Jelliff, who owns the local coal yard, drove in with a scowl on his red face. "Something's gone wrong with my generator," he growled. "The needle of the ammeter won't move off the zero mark. Get it fixed up in a hurry, will you, Gus? I'm busy as the very devil, and I need this car. How long will it take?"

"That depends on what's the matter with it," Gus told him. "Leave your car here. I'll get right at it."

Gus removed the generator from the car, and checked it carefully. Finding nothing at all wrong with it, he reinstalled it, started the engine, and looked at the ammeter confidently. The ammeter hand stayed at zero.

Gus switched on the lights. The hand continued to stay at zero.

Gus swore. Then he checked the wiring behind the dashboard thoroughly, and again started the engine. The hand stayed at zero.

This time Gus didn't swear. Instead, he lighted his pipe and contemplated the instrument panel. The oil gauge, temperature indicator, and gas meter, with the ammeter below them, were inclosed in one group behind a glass face set in flush with the dash.

"Ammeter must be busted," Gus said to himself. Reaching under the dash he disconnected its wiring, removed the screws which held it in place.

Even with the screws removed, it took quite a yank to get the ammeter free. When it came, it came suddenly. And pouring after it surged a stream of water.

"By golly!" cried Gus. "I'd have been less surprised to see pink elephants pop out!"

Wally had been watching. "First time I ever saw anything like that either," he observed. "Where did it come from?"

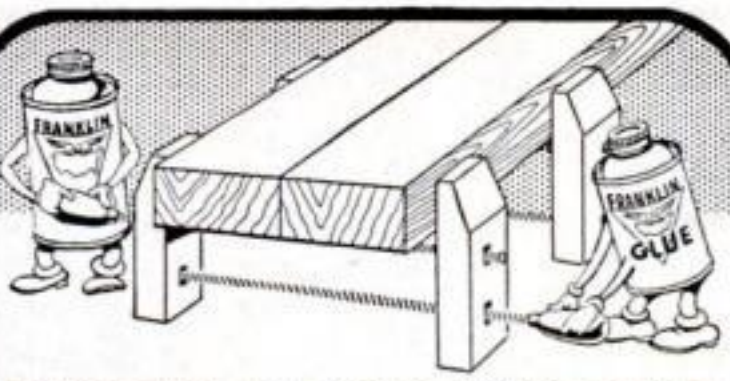
"It must have come from a windshield leak," Gus told him. "The water that leaks in runs down inside the instrument case. Enough water must have leaked in to bring it up into the lower part of the ammeter and put it out of commission. And I've wasted the better part of an hour!"

Along about six o'clock Joe Clark came into the shop to collect the day's time-and-material slips. After glancing over them, he remarked that he was glad to see that Gus had had a nice, easy day.

Gus glared at him. Then he laughed. "Sure," he said, "it was a regular rest cure for the old bean. Of course, there was that—" He broke off, and stared at Joe.

Joe stared back. "Got it, Gus?" he asked.

"Scram!" Gus yelled. "Yes, by gum, this time I think I've got it!"



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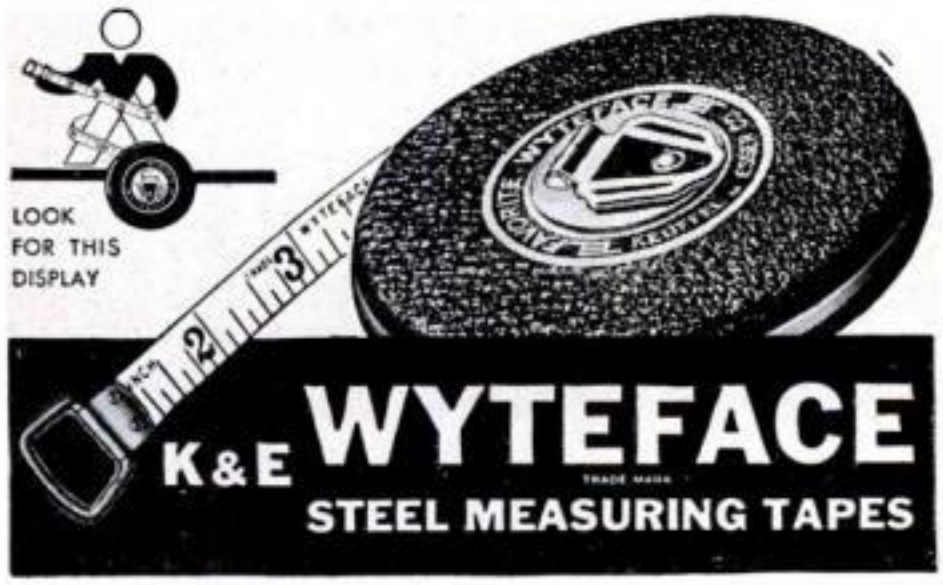

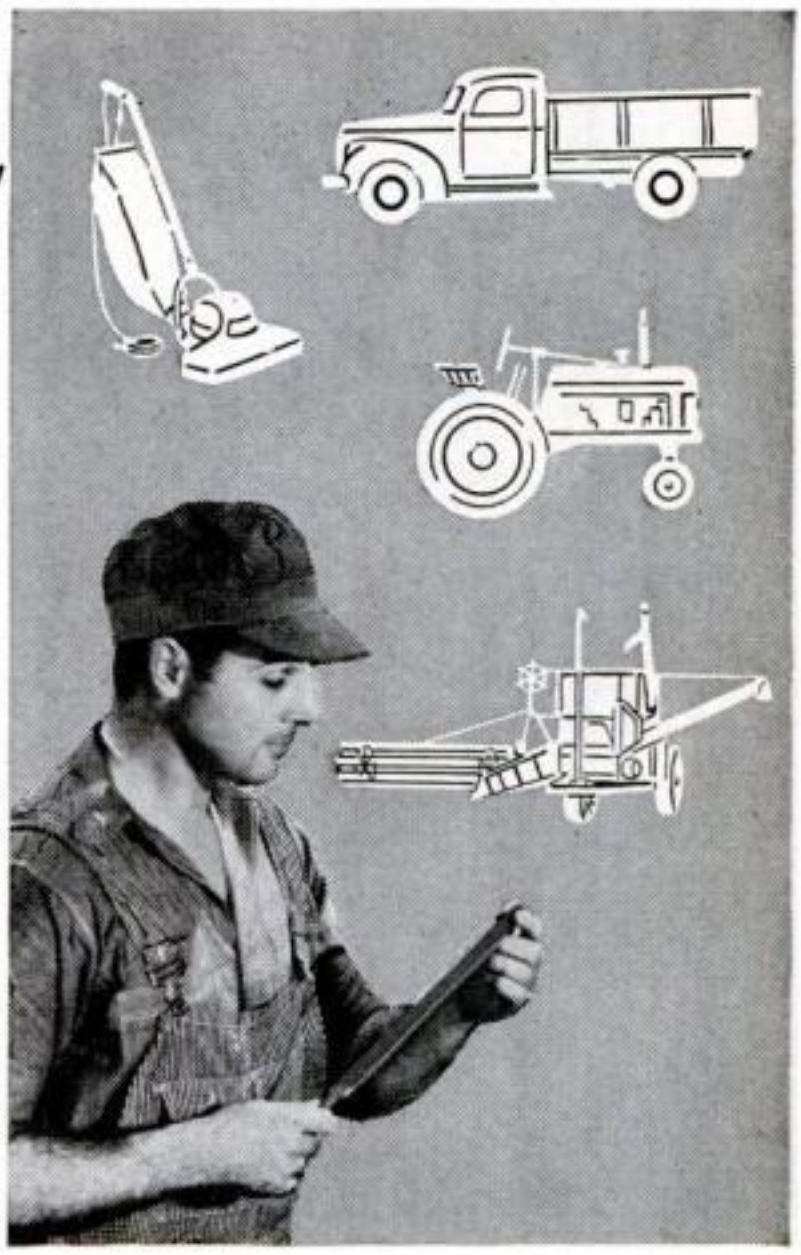

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Diving Artillery

(Continued from page 96)

this stuff worth a hoot, but Doc says eat it, and so I do," said the flyer across the table, attacking a large plate of salad greens. "We call it duty food."

"Doc" was the squadron flight surgeon, one of the most important men in this or any other military-aviation outfit. He was filling his flyers full of vitamins, especially vitamin A, which is found in the carotene of butterfat, carrots, and greens. Carotene has some mysterious chemical connection with the adaptation of the eyes for night vision; and these pilots were flying by night as well as by day.

Dive bombing, as military flying goes, is a simple operation; but, even more than some other types of piloting, it requires split-second reaction. The dietary care was but one example of the strict regimen which it was necessary for the pilots to follow in order to maintain efficient operation.

The flight surgeon's job, as applied to this or any other squadron, is another story. But with the diving outfit there is one aspect of his work which has to have special emphasis. That is the watch he must keep on the upper respiratory organs of the flyers. The change of atmospheric pressure in an 8,000-foot dive is so violent and sudden that anything wrong with the nose or throat is likely to give the pilot great trouble with his ears.

I had an example of this myself, the second time I tried a dive, forgetting that I had a slight nasal irritation. Watching the ground rushing up at us, I also forgot to swallow and thus ventilate my middle ear. Half way down, there came a sudden sharp jab of pain in my left ear, which increased with each foot of dive until by the time we reached the ground the pressure on the eardrum was agonizing. It was a half hour before the pain was relieved, three weeks before that ear felt normal again.

They explained to me what had happened. The eardrum separates the outer and inner ears. The outer ear is connected directly to the atmosphere, but the inner ear is thus connected only by the small Eustachian tube, which runs into the throat at the nasal pharynx. The pressure in these two chambers should be equal. When we climb in an airplane, atmospheric pressure decreases, and the compressed air in the inner ear easily escapes through the Eustachian tube. But when the process is reversed, the air has a much harder time getting back. Swallowing helps it. That's the reason for the

(Continued on page 222)

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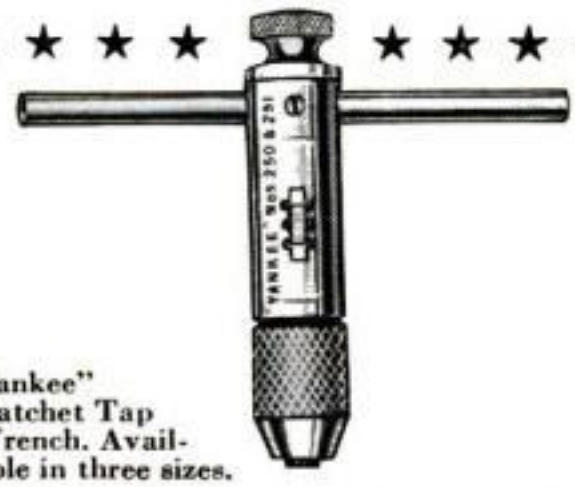

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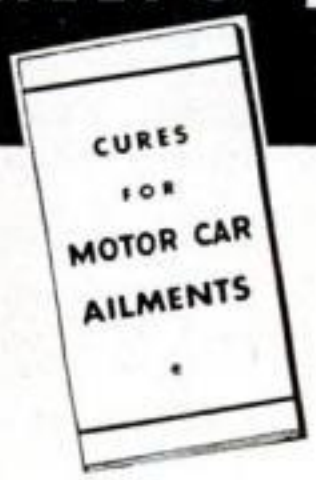

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Diving Artillery

(Continued from page 220)

chewing gum they give you in an airliner. When descent is gradual, there is usually no special problem.

But in a diving descent, the pressure increases very suddenly, by more than one third within a few seconds. At 9,000 feet the barometric pressure is 21.38 inches of mercury, while at 1,000 feet it is up to 28.86 inches. Under this sudden change the soft mouth of the Eustachian tube is likely to collapse, like a rubber tube which is sucked. Then the increasing pressure seals it against the entrance of air and the eardrum has to absorb the pressure by bulging inward.

The least cold in the head or sore throat, by swelling the opening of the tube or clogging it, exaggerates these difficulties. In addition, any throat infection is likely to be carried into the ear by the inrush of air. At the least sign of such trouble, the flight surgeon puts the dive bomber down for duty not involving flying.

This 8th Bombardment Squadron is a venerable outfit, with traditions going back to World War days. It had a great deal to do with developing the Army's technique of low-level attack bombing. But except for the commander, its veterans were transferred when it took up its new specialty. These dive bombers were youngsters fresh out of flying school, hot with enthusiasm for the development of what was for the Army a new type of flying.

They had learned it quickly, for as military flying goes it is a very simple thing. It involves none of the intricate teamwork between pilot and bombardier in using a bomb sight, none of the elaborate corrections required by level-flight marksmanship. Dive bombing is basically just another maneuver in the flying of an airplane, and after a few principles are explained to the flyer, the rest is practice. Of course there are tricks to it, just as there are tricks about making a basketball go through the hoop, but those are within the realm of military secrecy.

Up to now we have heard of dive bombing mainly during the German offensives in Europe. The next time it breaks into the news may well be when the American Fleet engages the Japanese. All our naval pilots are dive bombers, along with their other skills, and the art is one of our main naval weapons. With our war now centering in the Malay Archipelago, a combination of sea and air campaigning, dive bombing may well assume an importance greater than has ever been anticipated.

Old Man River Loses His Kinks

(Continued from page 72)

levees on the east side of the basin. Its waters will be carried to the Gulf by the lower Atchafayala River and the Wax Lake outlet.

On the upper Mississippi, between St. Louis and St. Paul, where a drop of 324 feet in 725 miles makes a swifter stream, 26 locks and dams have been built. The dams have gates, some of them 80 feet long, which are rubber-sealed and electrically heated so as to work easily in spite of frost or high water.

All this has been carried out in accordance with a plan which took into consideration the entire watershed of the great river with a view to expediting floods on their way to the Gulf. The cut-offs are spaced so that their effect is cumulative and these effects were calculated in advance at the Vicksburg Waterways Experiment Station where a microcosmic Mississippi betrays the secrets of its mighty prototype.

To gauge its pretzel-bending strength a miniature stream was turned into a straight channel marked out in a bed of fine coal dust 140 feet long and 40 feet wide, the rivulet being laden with coal dust in proportion to the Mississippi's silt load. In two hours the rivulet was beginning to diverge from its channel here and there. Floods and droughts were staged at proper intervals on the 140-foot stage and deep S-bends began to appear, shifting majestically downstream as they do in the Mississippi at the rate of 150 feet a year. Colored particles were sprinkled into the stream's sediment and faithfully revealed where and how quickly bars were formed in the real river.

For the study of flood water the experiment station has a faithful model in concrete of the lower Mississippi a quarter of a mile in length. To get the effect of local rainfall along the valley, additional water is poured in here and there, retarding screens checking the inlets at points where forest growth would release the rainfall gradually. On this scale model the progress of an entire 24-hour day is made in 5.4 minutes and the whole course of a spring flood can be watched in a few hours.

The scientific approach of the engineers was regarded with considerable skepticism at first by river men, who were inclined to think that the newcomers were wasting their time and the public's money on a lot of fool gadgets. The river creed was that a

(Continued on page 226)

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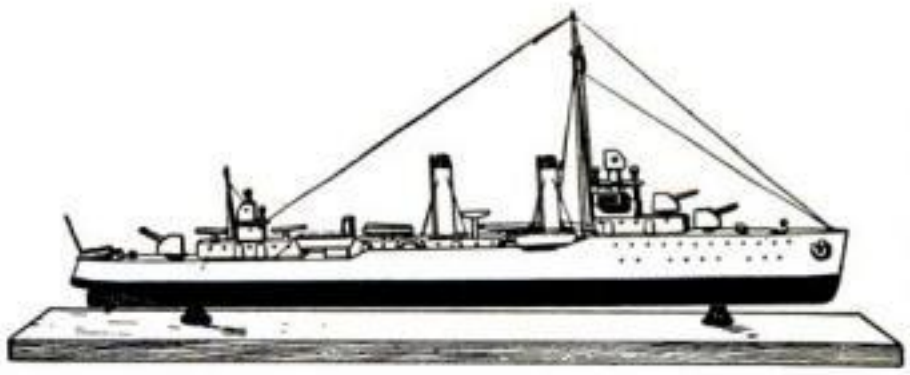

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Note: If you live west of the Mississippi River, add 50 cents to prices marked with an asterisk (*) and 25 cents to prices marked with a dagger (†).

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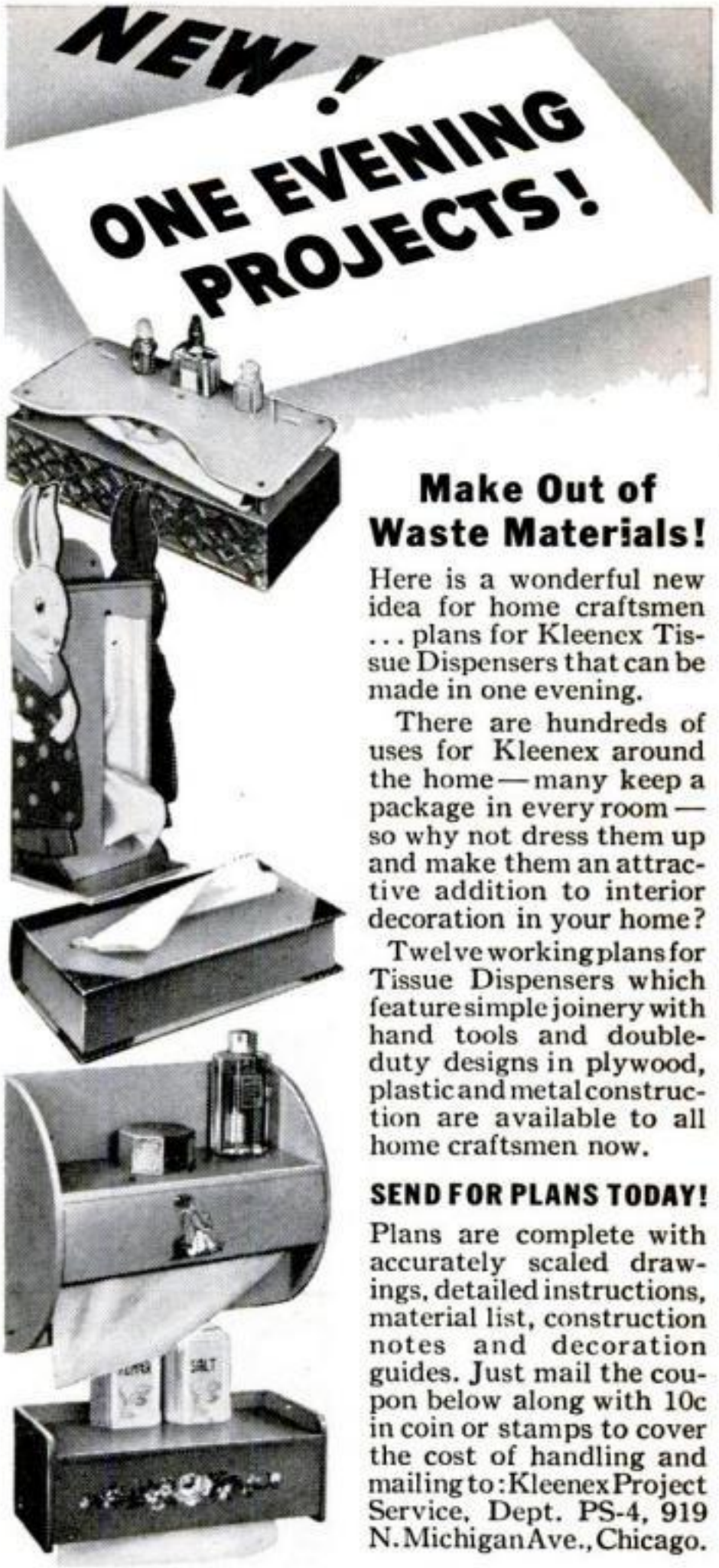

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Old Man River Loses His Kinks

(Continued from page 223)

man had to grow up with the stream to know it. Conciliation was the watchword of the engineering forces, however, and eventually they won the coöperation of the old-timers.

Boats busy in remote districts keep in touch with the staff by radio and the information thus assembled concerning the latest vagaries of the Mississippi is made available promptly to river pilots. Revised channel reports are posted in boxes along the banks to be picked up by river men just as in the days when Mark Twain was mastering the art of piloting a Mississippi packet.

From the first it was obvious that landsmen would benefit from the enterprise, living safer and more profitable lives because of it. Even the most obdurate river man would have to acknowledge now that river traffic was benefiting also.

Many of the old stern-wheel towboats still are in use, but a dozen transportation companies now are operating huge steel barges of a design contrived especially for the Mississippi River, propelled half a dozen or so at a time by a Diesel-powered tug whose specially designed propeller gives it additional power in tough going.

The river boats push their cargo barges instead of towing them astern, and on a big tow the leadsman may be a fifth of a mile ahead of his motive power. In such cases, the ancient cry of "mark twain" is relayed to the pilot by radiophone..

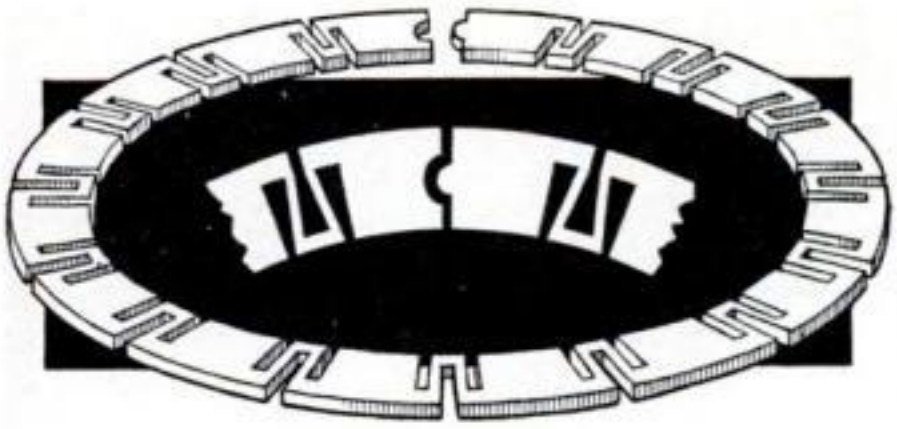
The new towboats, some of which develop 2,000 horsepower, have twin screws and, in some cases, six rudders, the latter to facilitate guidance of their clumsy burden, especially when in reverse. The screws are surrounded by the Kort nozzle, a power-gaining device which has been in use for some time in European waters.

The twin screws are surrounded by a built-in band of steel with an airfoil edge like an airplane wing. This insures an even indraft of water in choppy weather, reduces the suction draft on the flanks of the boat, and kicks its water astern in a solid column instead of the more diffuse fan of the ordinary screw wake. The band or nozzle permits operation in shallow waters and protects the screws also from obstacles.

Further cut-offs and improvements are contemplated by the engineers, but they feel certain now that they have a bridle on the Mississippi and can ride him.

With the Inventors

BY ADJUSTING itself to the contours of worn cylinders in automobile engines, a new type of piston ring compensates for localized as well as general distortions. It owes its flexibility to a series of partially slotted portions, spaced at intervals around



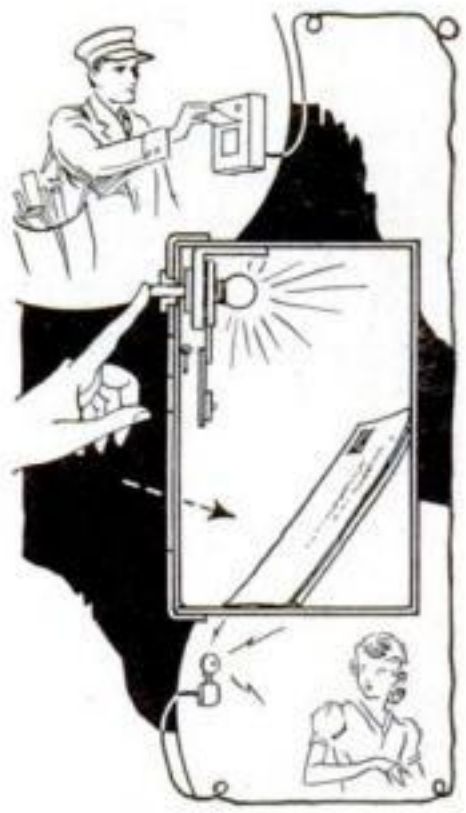
the circumference of the ring. After the slots have been punched, the ring is compressed until their width is reduced to about 4/1,000 or 5/1,000 of an inch. Thus the elastic quality of the ring is obtained without loss of compression in the motor. Squeezing the ring changes each set of slots from a U shape, as shown in the larger view, to a V shape, as illustrated in the enlarged section. According to the inventor, Victor F. Zahodiakin of Forest Hills, N. Y., his idea may be applied to all types of internal-combustion engines; and similar pieces may serve as packing rings for the pistons of pumps and steam engines. . . . TO END THE DEPREDATIONS of moles in lawns and gardens, a poison gun has been developed by David A. Smith of Salem, Ore. In form, the tool resembles a short, pointed cane. Its handle operates an inner plunger, and the device carries on its side a bottle of rodent poison. For use, the pointed end is thrust into a mole burrow, and the handle is raised and then thrust back. By this action, a valve admits a measured charge of poison to the barrel, and a plunger then forces it out, through an aperture in the point, into the burrow. . . . A MAILBOX DE LUXE, for a house or apartment, automatically notifies the household if a letter has been delivered. Inserting an

(Continued on page 228)

With the Inventors

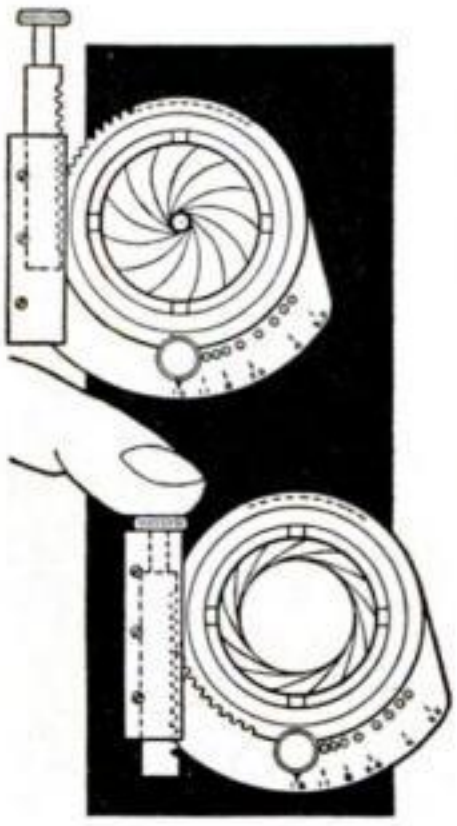
(Continued from page 227)

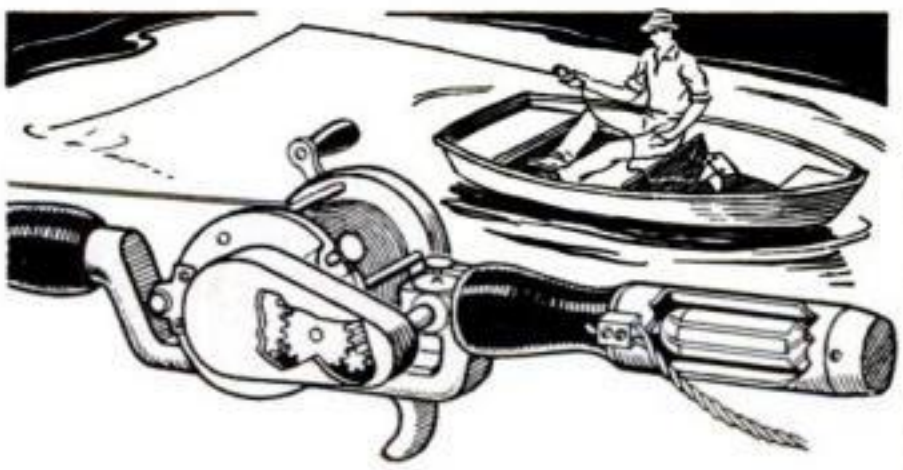
envelope in its slot actuates a pendulum that intermittently sounds an interior bell for a predetermined time, as shown in the two small views. The postman can also operate the bell with a push button, in case he is delivering a piece of registered mail. Still another advantage has been added by the inventor, L. A. Rocheleau of Detroit, Mich. If no one has been at home during the day, the user need not unlock the box at night and fumble within to see if mail has been delivered. Instead, a second push button illuminates the inside of the box, so that its contents may plainly be seen through a window in the front, as shown in the center view. Current for operating the lamp and bell is provided by connections to the ordinary doorbell transformer. . . . FOR DELIVERING ORDERS to the crew of a speeding train, F. H. Daugherty, railroad telegrapher of Chico, Calif., has devised a portable safety appliance. Even though a train slowed down, it was formerly a dangerous practice for station operators to hand up messages on conventional, long-handled hoops. In the new invention, a lightweight standard bearing the hoops may be set up in a permanent socket on the platform, and removed to avoid obstruction when not in use. The illustrations shows it with two hoops in place, at convenient heights to be picked up from an engine and a caboose. When the engineer or conductor slips his arm through a hoop, it slides smoothly from the post without drag or jar. At night, a flashlight mount-



With the Inventors

ed on the standard clearly indicates the position of the rings. As many as four hoops may be used, for a train including three locomotives and a caboose. . . . A NEW IRIS-DIAPHRAGM CONTROL, especially suited to cameras of reflecting type, makes focusing quick and easy when less than the full aperture of the lens is used. First, a graduated ring presets the diaphragm, according to the desired depth of focus and the light conditions. Next, a finger's touch on a plunger temporarily opens the diaphragm wide, giving a bright image on the ground-glass screen for accurate focusing. Then, merely releasing the plunger returns the diaphragm to its preset position, by the action of a spring. Devised by Joseph H. McNabb, of Winnetka, Ill., the invention has been assigned to a prominent American camera manufacturer. . . . A MOTOR-DRIVEN REEL, built into a casting rod of standard design, makes life easy for a fisherman. The electric motor, encased in the handle, spins the reel





by means of a train of gears and an ingenious clutch. Since the centrifugally actuated clutch dogs will not engage the reel until their gear-wheel mounting reaches a speed of 600 r.p.m., the motor unit does not interfere with a cast. Of the two small buttons visible in the illustration, the forward one serves as a brake for slowing the reel spool; the other closes a contact that starts the motor to reel in the line. The motor operates on direct current from a battery. The inventor is T. C. Fanshier of Oklahoma City, Okla.

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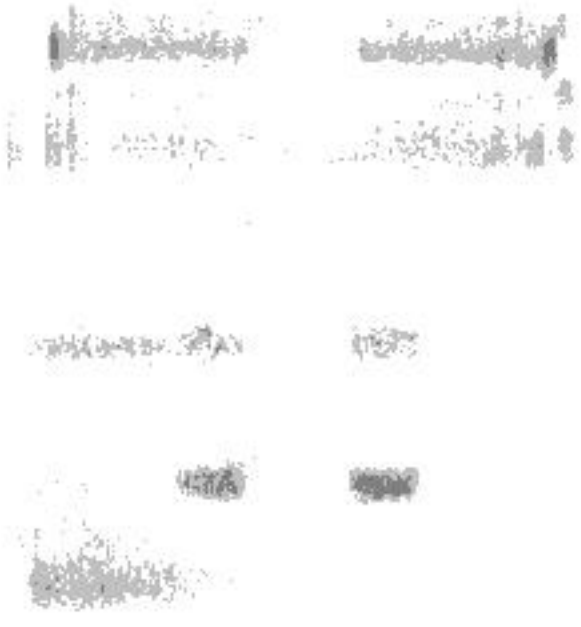

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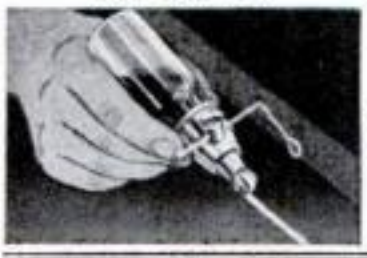

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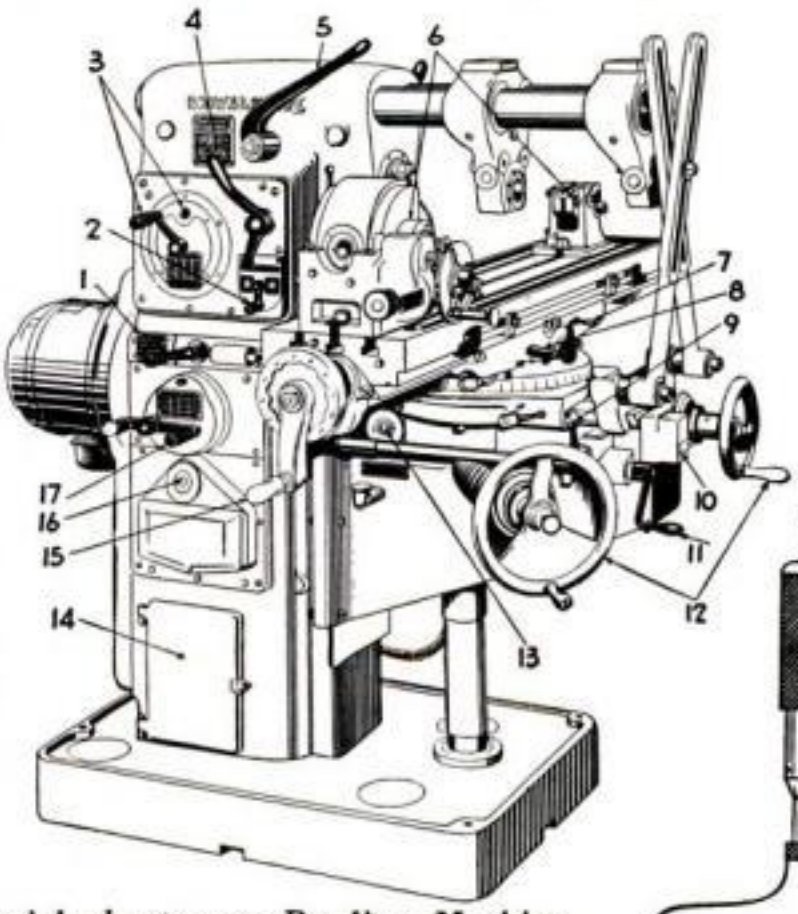

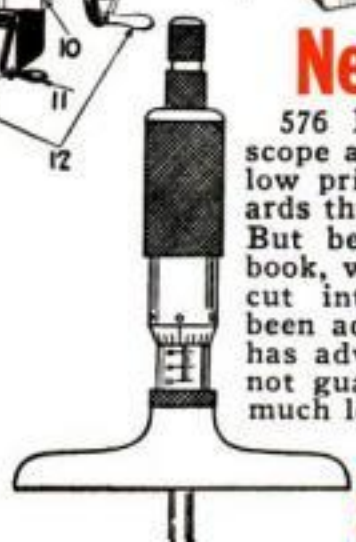

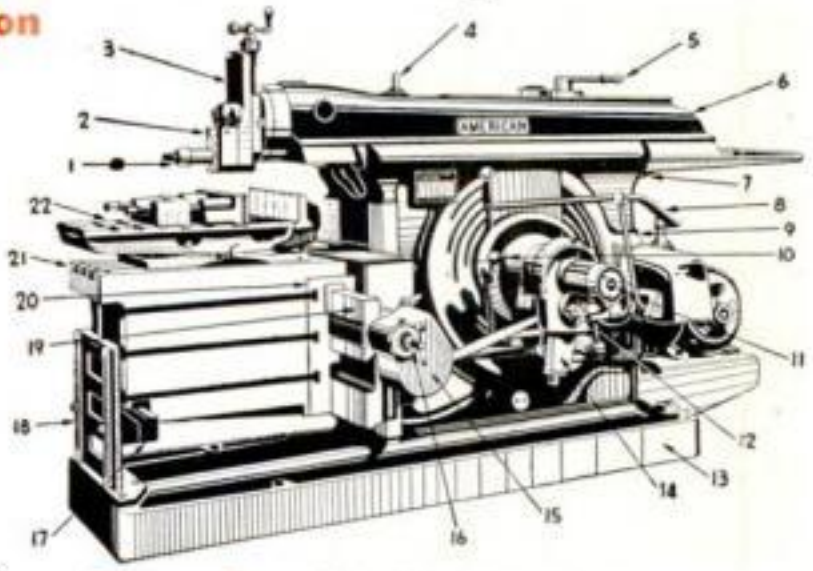

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THE name is Lennox – Peggy Lennox. She may not look the part of a trainer of fighting men, but–

She is one of the few women pilots qualified to give instruction in the CAA flight training program. And the records show she's doing a man-sized job of it. She's turned out pilots for the Army . . . for the Navy. Peggy is loyal to both arms of the service. Her only favorite is the favorite in every branch of the service–Camel cigarettes. She says: "It's always Camels with me–they're milder in every way."

Don't let that smile fool you. When this young lady starts talking airplanes – and what it takes to fly 'em – brother, you'd listen, too . . . just like these students above.

FLYING INSTRUCTOR
PEGGY LENNOX SAYS:

"THIS IS THE CIGARETTE FOR ME. **EXTRA MILD**– AND THERE'S SOMETHING SO CHEERING ABOUT CAMEL'S **GRAND FLAVOR**"

With Instructor Peggy Lennox, it's strictly Camels. "Mildness is a rule with me," she explains. "That means slower-burning Camels. There's less nicotine in the smoke."

● "Extra mild," says Peggy Lennox. "Less nicotine in the smoke," adds the student as they talk over Camels in the pilot room above.

Yes, there *is* less nicotine in the smoke of Camels...extra mildness ...but that alone doesn't tell you why, with smokers in the service ...in private life, as well...Camels are preferred.

No, there's something *more*. Call it flavor, call it pleasure, call it what you will, you'll find it only in Camels. You'll *like* it!

R. J. Reynolds Tobacco Company, Winston-Salem, N. C.

The *smoke* of slower-burning Camels contains

28% LESS NICOTINE

than the average of the 4 other largest-selling cigarettes tested–less than any of them–according to independent scientific tests *of the smoke itself!*

● BY BURNING 25% SLOWER than the average of the 4 other largest-selling brands tested –slower than any of them –Camels also give you a smoking *plus* equal, on the average, to

5 EXTRA SMOKES PER PACK!

CAMEL – THE CIGARETTE OF COSTLIER TOBACCOS